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Published every Friday by
The Machinery Publishing Co., Ltd.

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Price 1/3

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MACHINERY

A JOURNAL OF METAL-WORKING PRACTICE AND MACHINE TOOLS

Vol. 92, No. 2361 February 14, 1958

COPIES PRINTED.....11,500 per week

CERTIFIED DISTRIBUTION.....11,376 per week

CERTIFIED PAID DISTRIBUTION.....10,566 per week

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Abstracts of Principal Articles

Making the Massey-Harris Ferguson-35 Tractor ..... P. 352

A number of articles has already been published in MACHINERY describing some of the interesting plant installed at the Banner Lane factory of the Standard Motor Co., Ltd., Coventry, for producing the new Ferguson-35 tractor. This plant, which cost about £4½ million, includes a large number of in-line, rotary, and drum-type transfer machines. The present article is concerned with a 3-section Heller in-line machine of advanced design, and an Archdale 2-section Unimatic transfer machine, which, together, perform all the machining operations on the cast-iron centre housing of the tractor in a cycle time of only 100 sec. On the Heller machine, the castings are clamped automatically on the fixture platens by hydraulic means, and during automatic transfer from one section to the next, they are re-positioned so that operations can be carried out on the various faces. The Archdale machine provides principally for drilling and tapping operations, and here the workpiece clamps are applied by hand. (MACHINERY, 92—14/2/58.)

Autronic Electro-magnetic Clutch and Brake Units ..... P. 365

Electro-magnetic clutch and brake units of the Autronic patented design, which was introduced some 10 years ago, are now being used with good results in machine tools and many other kinds of equipment. They are available with disc elements from 1 in. to 9 in. diameter, which provide static torque capacities from 30 oz.-in. to 396 lb.-ft., and the arrangement of a wound magnet disc, a plain armature disc, and a thin floating plate provides for high torque capacity in relation to size, and very smooth yet rapid engagement. In this article, details are given of the design features and performance of these units. (MACHINERY, 92—14/2/58.)

Gear Production for the Buick Flight Pitch Dynaflow Transmission ..... P. 368

Gears for the Buick Flight Pitch Dynaflow transmission are being manufactured at lower cost and higher output rates as a result of the adoption of completely automatic processing. Blanks for the rear driven pump gear are cut from seamless steel tubing, on multi-spindle automatics, and, after a stress-relieving treatment, are processed through grinding, turning, boring, broaching, deburring, inspection and classification on an integrated line, controlled by a combination of electrical and mechanical systems. Automatic loading and unloading equipment is provided for the various machines, and work-elevating and storage units balance out the slower and faster operations. (MACHINERY, 92—14/2/58.)

Interferometer for Checking the Parallelism of Slip Gauges..... P. 375

In this instrument, a slip gauge to be checked is supported on a perforated plate, and light is directed simultaneously on to the upper and lower surfaces by way of a double image Kösters prism and a right angle prism. Images of the interference patterns on the upper and lower surfaces can be observed side by side in the eyepiece. To enable a direct reading of the mutual inclination of the surfaces to be obtained, the two portions of the Kösters prism are set at a very small angle to one another, and an adjustable, circular glass wedge is interposed in the path of the light rays which fall on the lower surface of the gauge. With this arrangement, the wedge can be adjusted until two sets of fringes, observed in the eyepiece, are parallel to one another. (MACHINERY, 92—14/2/58.)

Automatic Position Indicator for Use with Dynamic Balancing Machines..... P. 377

The indicator here described has been developed to facilitate marking workpieces on dynamic balancing machines to show the angular position of unbalance. It is based on the principle that when an electric discharge takes place within a liquid contained in a small cavity from which there is an outlet, some of the liquid is expelled through that outlet. The spark is passed at the peak of the unbalance signal of the machine so that the marking fluid is projected on to the surface of the work at the required position. It is stated that satisfactory results can be obtained when the distance from the indicator orifice to the surface does not exceed ⅜ in. (MACHINERY, 92—14/2/58.)

Drilling Small Holes by the Ultrasonic Method..... P. 379

It was required to drill 0·015-in. diameter holes in ferrite cores to receive windings of fine copper wire. The problem was eventually solved by using small ultrasonic heads which were specially made for the purpose. Exponential-cone extensions are employed with these heads, and each extension has a 0·020-in. hole in which the 0·013-in. diameter brass wire drill is free to rotate. The operation is started "dry" with a drill that is already impregnated with diamond dust, and a very small amount of this abrasive, in paste form, is subsequently applied. Rotary motion of the drill is induced by adjustment of the waveform generator. (MACHINERY, 92—14/2/58.)

IN FORTHCOMING ISSUES

The production of VDF standard lathes—Industrial Technics co-ordinate drilling machine with automatic positioning.

The Gauge and Tool Exhibition

As a means of increasing productivity and work quality throughout the metal-working industries, there can be no substitute for new machine tools, incorporating the numerous developments which have been introduced during the post-war years. It is to be hoped, therefore, that the restrictions on investment in machine shop equipment, which have been imposed by the prevailing financial policy of the Government, will be speedily relaxed, in order that the problems of inflation can be tackled in more realistic fashion. The greater accuracy, rigidity, and power, higher speeds, and improved control systems of modern machine tools, have all contributed to the attainment of higher outputs and increased precision. Much of the advantage of these developments, however, would have been lost if there had not been parallel advances in connection, for example, with cutting tool materials and designs; jigs and fixtures; automatic work loading and handling equipment; and gauging arrangements.

To an increasing extent, indeed, the equipment is becoming complementary rather than subsidiary to the basic machine, and the tendency is to provide, where possible, for automatic transfer of work to the machine, automatic loading and clamping, automatic unloading, and automatic probing or gauging to determine whether operations are being correctly performed, or work size maintained. In this way, operators or tenders may be largely relieved of physical and mental routine effort, and each may be able to supervise a number of machines. Even more important than the labour savings thus achieved, may be the fact that, on each machine, the interval between successive cycles is reduced to a constant minimum, so that there is a saving in overall time for given speeds and feed rates. At the same time, with well-designed fixtures, arranged for power clamping, it may be possible to increase metal-removal rates without any adverse effects on work quality, and with correct selection of cutting tools, speeds and feeds, may often be raised without adverse effects on tool life.

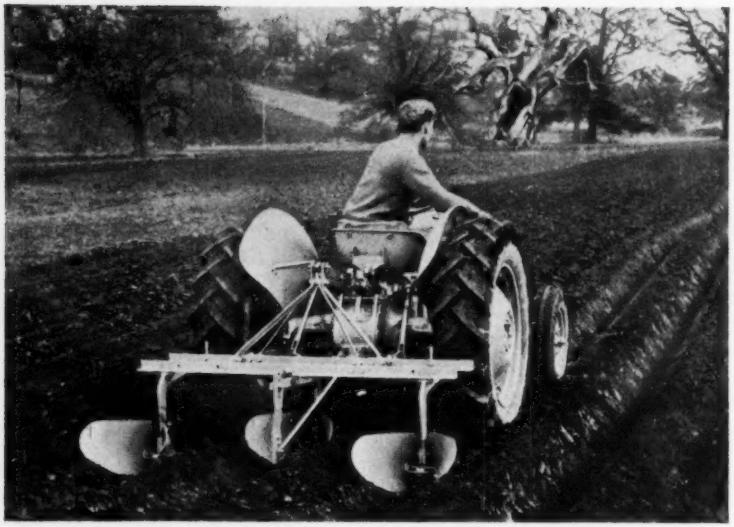
The extent to which the tooling equipment controls work quality depends, of course, upon the nature of the operation. Sometimes it is possible to produce high-precision parts on old and worn machines by the use of jigs which entirely control the positions of both work and tools. For such processes as closed die forging, die casting, and plastics moulding, moreover, the machine builder can only provide the means of bringing the tool members together in accurate alignment, and it then remains for the tool-maker to ensure that the desired results are obtained.

By reason of the trends to which attention has been briefly drawn, the gauge and tool industry continues to grow in size and importance, and the series of exhibitions which has been organized, since the war, by the Gauge and Tool Makers' Association, has necessarily proved of increasing interest to production engineers. The fifth of these exhibitions is to be held in May, and finding that it had outgrown the capacity of the hall in which these events were previously staged, the Association, with characteristic enterprise, have arranged for its transfer to the National Hall at Olympia, where it will occupy both the ground floor and the gallery. Added interest will be lent by the participation of the affiliated British Power Press Manufacturers' Association, and by the fact that, with the increased space at their disposal, many exhibitors will take the opportunity of demonstrating their products on machine tools. In this way, attention can be drawn to their potentialities much more effectively than is possible with purely static displays.

Gauges and tools—using the latter term in its widest sense—are inevitably expensive, by reason of the quality of workmanship and materials demanded. In proportion to the benefits conferred, however, the cost is often very modest, and visitors to the exhibition, from all branches of the engineering industries, many of whom may have been compelled temporarily to interrupt programmes of machine replacement, will be afforded a diversity of opportunities for achieving better results from existing plant.

Properly—as we have suggested—new tooling and machines should go together, but if the purchase of machines must be postponed for financial reasons, it is all the more important to ensure that the best possible use is made of those that are already installed. Standard types of gauges and consumable tools are usually purchased from specialist firms, but many jigs, fixtures, dies and moulds are made in tool-rooms attached to manufacturing establishments. There is, however, a growing appreciation of the advantages of entrusting more of this work to firms better qualified, by reason of their experience and equipment, to undertake it. For a number of years gauge and tool makers have been heavily committed, partly on account of demands relating to production for national defence. Now that the pressure has lessened, it is important that industry should take full advantage of the facilities available.

Making the Massey-Harris Ferguson-35 Tractor



Methods Employed for Machining Centre Housings at the Banner Lane Factory of the Standard Motor Co., Ltd.

Articles have already been published in MACHINERY* describing the methods employed for the production of a number of the major components of the recently-introduced Massey-Harris Ferguson 35 tractor which is being manufactured on a large scale at the Banner Lane works of the Standard Motor Co., Ltd., Coventry, and supersedes the original and highly-successful Ferguson 20 type. Change-over to the production of the new tractor has involved complete reorganization of the Banner Lane works, with the installation of new machine tools and equipment costing £4½ million.

The new plant provides for an output of 100,000 tractors per year, and is noteworthy for the very extensive use which is made of in-line, rotary, and drum-type transfer machines supplied largely by the German firms of Heller and Huller, also British-built machines by Archdale. These machines have enabled considerable economies to

* 90/624–22/3/57, 90/748–5/4/57, 91/120–19/7/57, 91/780–4/10/57, 91/896–18/10/57, 91/1360–13/12/57.

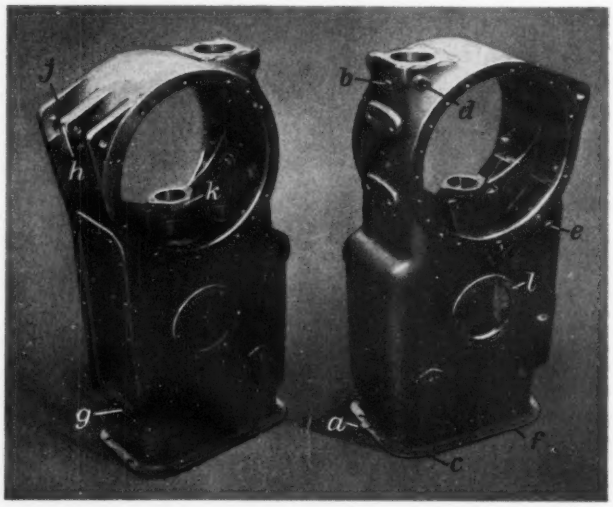


Fig. 1. Machined Cast-iron Centre Housings for the Massey-Harris Ferguson-35 Tractor

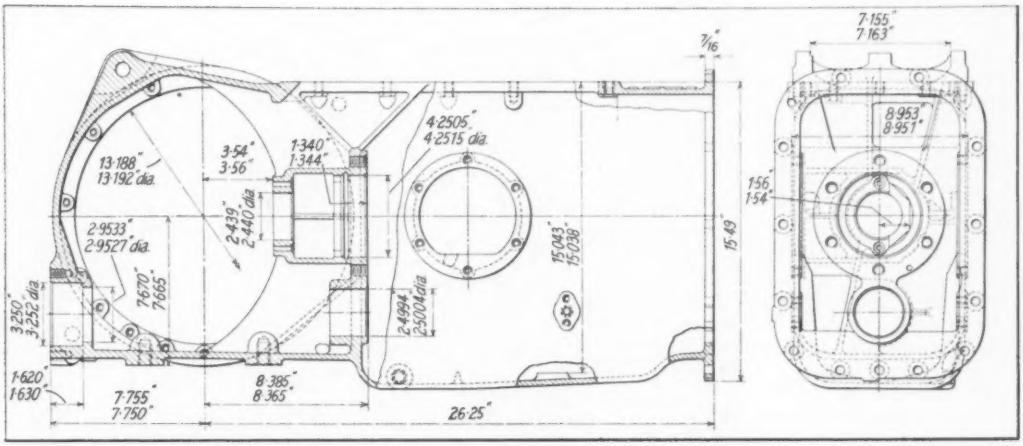


Fig. 2. Part-sectional Side and End Elevations of the Centre Housing which is Handled on the Heller and Archdale In-line Transfer Machines

be made as regards labour requirements, in addition to ensuring smooth production flow. Transfer machines concerned with transmission housings, front mounting brackets, rear axle housings, hydraulic lift covers, differential casings, rear axle shafts, differential pinions, gear-change levers, and engine sump castings, have been discussed in previous articles. Here, details are given of an outstanding installation of Heller and Archdale in-line machines for carrying out, in a cycle time of 100 sec., all the operations on the cast-iron centre housing shown in Fig. 1, and the drawing Fig. 2. The centre housing forms part of the " back-bone " of the tractor, and the flanged end face is bolted to the transmission housing, which, in turn, is bolted to the engine crankcase. It contains the main-drive differential sub-assembly, the hydraulic pump for implement control, and the power take-off shaft, with associated sliding clutches. Spigoted and bolted to each side of the centre housing are

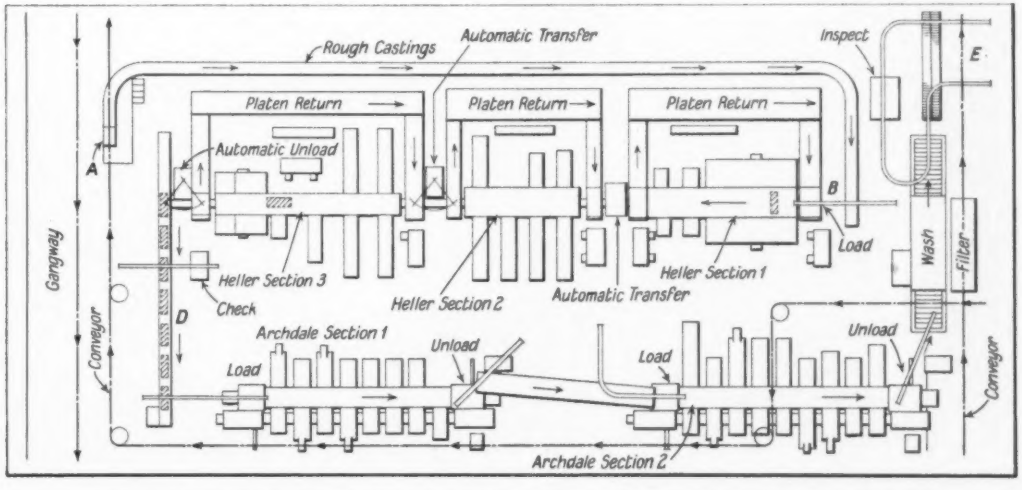


Fig. 3. Floor Layout of the Heller and Archdale In-line Transfer Machines for the Centre Housing

the malleable-iron rear axle housings, as may be seen in the heading illustration, and on the machined top face is fastened the anchor cover and hydraulic control assembly for the implement linkage.

Fig. 5. A General View, from the Finishing End, of the Heller Transfer Machine for Centre Housings

MACHINING SEQUENCE

The arrangement of the Heller and Archdale machines, parallel to each other, and at right-angles to the main gangways of the shop, is shown in Fig. 3. As has been explained in previous articles, the principal castings for the tractor are delivered to the machine lines by an overhead chain conveyor, after being shot blasted and dipped in primer paint in an adjacent department.

Centre housings are unloaded from the conveyor by an operator at the point *A*, with the aid of an air-operated, rising table, which serves to take the weight of the casting as it is being unhooked from the conveyor chain. The castings are then placed on a slightly inclined roller conveyor, down which they move to the turn-over station *B*, at the starting end of the Heller machine. At this station, which is also seen in Fig. 4, the casting, resting on its flanged end face, is pushed into a cradle, when the latter is vertical, and air is then admitted to the cylinder *C*, by way of a hand-operated valve, to bring the cradle to the position shown, in readiness for picking up the casting and loading it into the machine fixture with the aid of an overhead electric chain block.

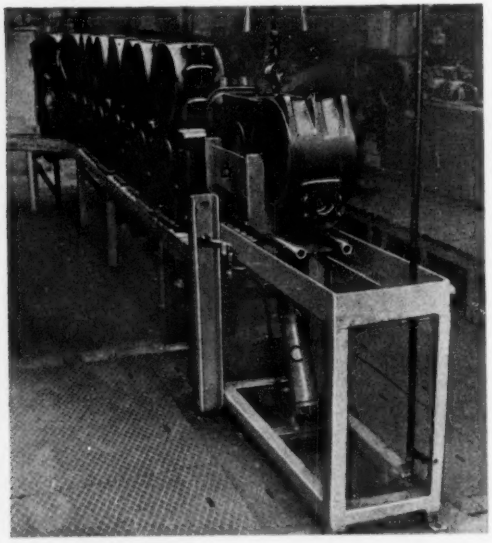


Fig. 4. The Casting Turn-over Station at the Starting End of the Heller Machine

A general view of the Heller machine is given in Fig. 5. Referring to the layout, Fig. 3, this machine comprises three self-contained sections through which the castings pass on fixture platens, the latter being returned to the starting positions on wheeled trolleys which are traversed along runways by means of chains fitted with dogs. At the finishing end of the first section, the workpiece is automatically removed from the platen, and reloaded, in another position, on a platen in the second section, and this procedure is repeated between the second and the third sections. At the finishing end of the third section, the casting is automatically unloaded and deposited on a power-driven slat conveyor at *D*, Fig. 3, which conveys it to the starting end of the Archdale two-section Unimatic transfer machine. In this instance, the castings are transferred manually from the first to the second sec-

tion, and, upon completion of the operations, they are cleaned in a Dawson washing unit, inspected, and then loaded directly on to an overhead conveyor at *E*, which carries them to the tractor assembly line.

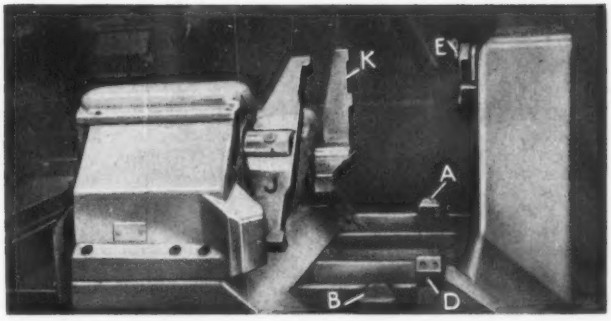


Fig. 7. A Side View of an Unloaded Fixture on the Heller Machine

FIRST SECTION HELLER PLATEN FIXTURE

For the series of operations performed in the first section of the Heller machine, the casting is held in the fixture transversely, and with the hydraulic lift cover face uppermost, as may be seen in Fig. 6, which is a view at the starting end, with the fixture supported on the wheeled transporter trolley *B*. When the "start-cycle" button is depressed, the hydraulically-operated transfer bar moves the fixture to the first machine station, and the empty trolley is then returned to the right, along the runway, by means of a dog on the chain *C*, ready to receive another fixture from the in-line runway indicated in Fig. 3. On the latter no trolley is employed, the fixture being traversed directly along the rails by means of a chain dog.

The casting is clamped and unclamped automatically by hydraulic power, and the fixture presents a number of interesting design features which will be described. In Fig. 7, an unloaded fixture, viewed from the right-hand side, is seen at the end of the in-line runway, waiting to be picked up by the trolley which carries it across to the loading position at the starting end of the machine. An end view of a fixture, with the cover removed to show some of the clamping mechanism, is given in Fig. 9, and Fig. 8 shows various sectional views.

Two small location pads are cast on the underside of the centre housing, one at *a* Fig. 1, on the front flange, and the other at *b*, adjacent to the boss for the power take-off shaft. For lateral location, cast pads are provided at *c*, *d* and *e*, and a compensating support on the fixture bears against the flange at the point *f*. Referring to Fig. 7, the casting rests in the fixture on fixed blocks *A* and *B*, and it is clamped sideways against a block *D*, and two other blocks which bear against the flange at *c* and the pad *e*, Fig. 1. The compensating support, which moves into engagement with the point *f* on the flange, is seen at *F* in Fig. 9. The seating block *E* is arranged to pivot freely between stop pins, so that it moves clear of the adjacent raised facing on the casting, as the latter is automatically unloaded vertically from the fixture at the end of the first machine section. Transverse location for the casting is taken from the back of the front flange, which bears against a vertical stop face on the block *A*, Fig. 7.

When the start-cycle button is pressed, the hydraulically-operated

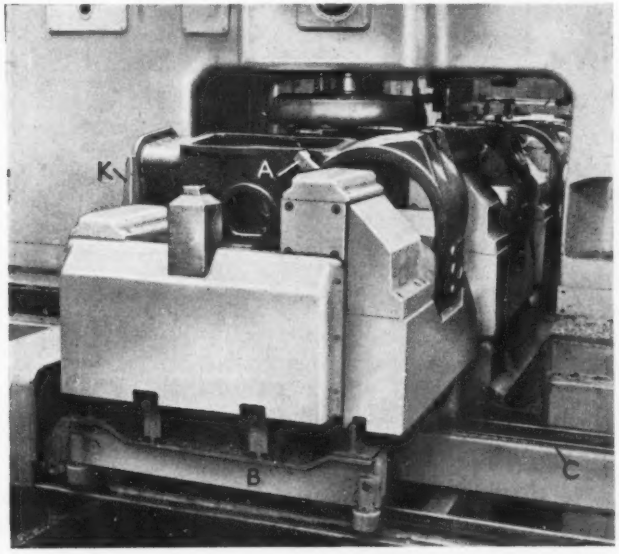


Fig. 6. A Platen Fixture, with the Casting Loaded, at the Starting End of the Heller Machine

transfer bar of the machine draws the platen off the trolley to the first working station, and before clamping takes place automatically at this position, a vertical hydraulic ram *G* and a side ram *H*, Fig. 9, engage the casting to hold it against the fixture location points. Clamping is then effected by horizontal movement of the two balanced rocker clamps *J* and *K*, Fig. 7. On the latter, it will be noted, the arms are at right-angles to each other, and the vertical arm engages the edge of the casting flange, as may be seen at *K* in Fig. 6. The other rocker arm may also be seen at *A* in Fig. 6.

Referring to the drawing, Fig. 8, one of the two bed-ways of the machine, on which the fixture platen rests and is clamped while the machining operations are in progress, is indicated at *L*. The platen is moved from the trolley on to T-headed support rails *M*, which extend for the length of the machine section and are carried on the rams of hydraulic cylinders *N* at each side of the bed. At this stage, the rails are in the raised position and engage two needle-bearing mounted rollers *P*, at

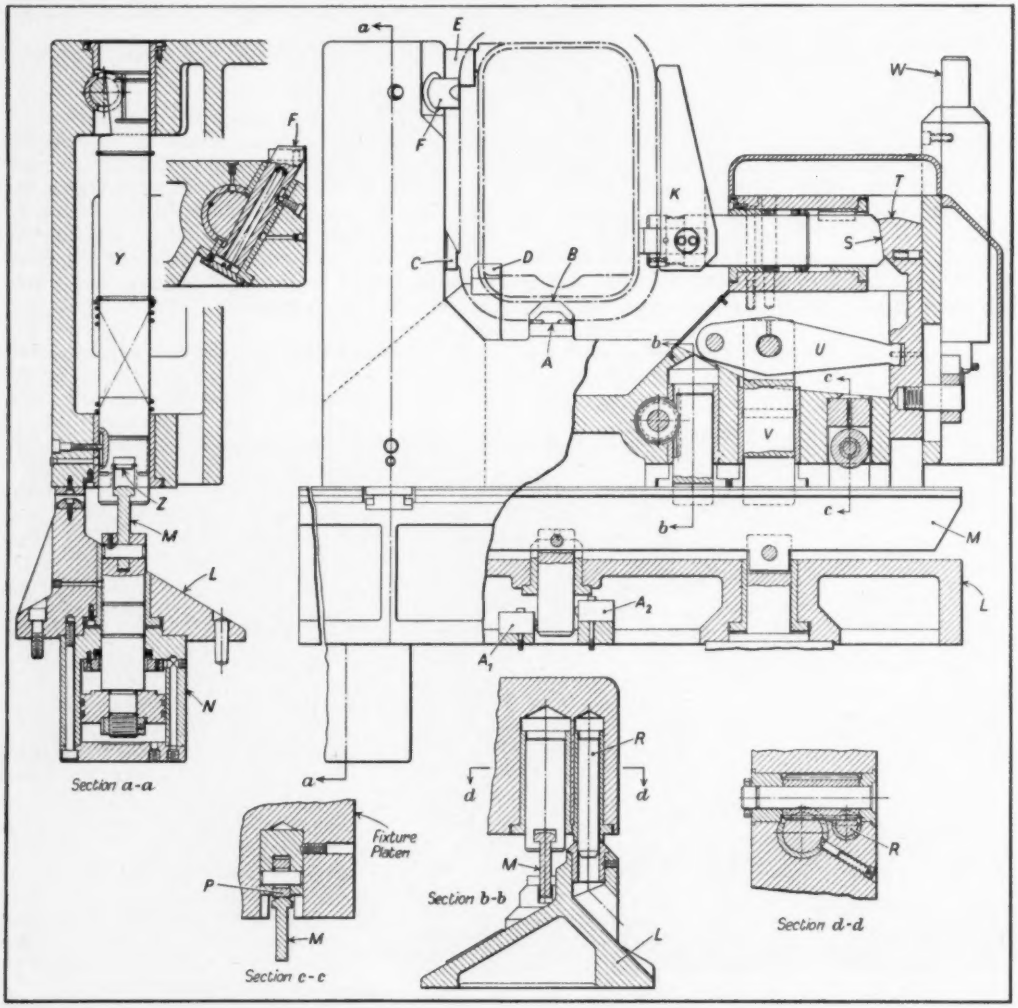


Fig. 8. Sectional View Showing the Construction of a Hydraulically-operated Fixture for the Heller Machine

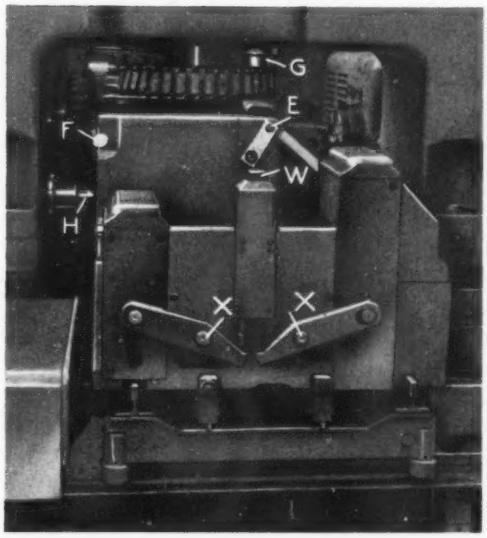


Fig. 9. End View of a Platen with the Cover Removed to Show Part of the Clamp Mechanism

each side of the platen. The latter is thus held clear of the bed as shown, so that during indexing from station to station it moves along the rails, and wear on the bed-ways is avoided. Downward movement of the T-headed rails to lower the platen on to the ways also operates location plungers *R*, through rack and pinion systems, so that they engage bushes in the bed. In addition, at the first working station, the locking mechanism for the workpiece is actuated and the pressure applied also serves to clamp the platen to the bed-ways. The work holding system is self-locking, so that the casting remains gripped throughout the machining sequence although the rails are raised and lowered for each indexing movement.

The rocker clamps *J* and *K* are operated independently from the right- and left-hand rails, the method being substantially the same for each. In the drawing, the mechanism for the clamp *K* is shown. The rocker arm is pivoted on a round bar which is prevented from rotating by means of a key and is provided with a tapered end face *S*. This face is engaged by a self-locking taper-ended bar *T*, which is moved downwards by the lever *U*, coupled, in turn, to a vertical pull bar *V*. At the lower end of this bar there is a T-slot through which the rail *M* passes. The two rocker clamps are only released at the end of the machine section, in preparation for unloading the workpiece and its transfer to the second section. Unclamping is effected by downward pressure on the bar *W*, also seen in Fig. 9, which strikes right- and left-hand levers pivoted at the points *X*, so that the taper bars *T* are caused to move upwards. The unlocking pressure is applied by means of a hydraulic ram at *A*, Fig. 11, which is carried on a bridge at the last station of the machine section.

The left-hand sectional view, Fig. 8, shows the method of operating the compensating support pad *F*. This pad is urged forward against the casting by an internal compression spring, and it is held in position by the vertical wedge bar *Y*, which engages a mating face on the side of the pad. The T-slotted lower end of the wedge-bar incorporates a striker plate *Z*, with which the rail *M* comes into contact to release the lock. The weight of the wedge-bar *Y* is supported by a compression spring so that the pad *F* can slide quite freely into contact with the workpiece. Safety limit switches A_1 and A_2, carried on the bed and actuated by a plunger attached to the rail *M*, ensure that the platen cannot be indexed, or the machining cycle started, until the locating and clamping functions have taken place in the correct sequence.

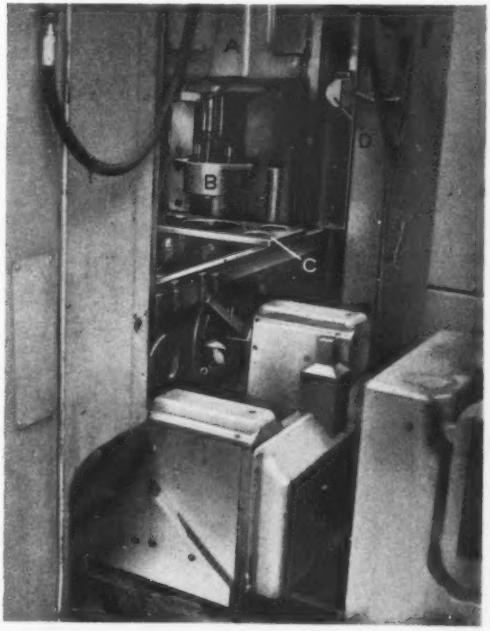


Fig. 10. A View of the Station on the Heller Transfer Machine at which the Two Location Holes are Drilled and Reamed

OPERATIONS IN THE FIRST MACHINE SECTION

At the first working station, the hydraulic lift cover face on top of the casting is milled to the dimension of 15·49 in. from the bottom location pad, using a 20-in. diameter cutter fitted with 48 tungsten-carbide-tipped blades. The cutter spindle is mounted in a vertical quill in a traversing bridge and rotates at a speed of 45 r.p.m. Also carried by the bridge are horizontal right- and left-hand, quill-mounted spindles, fitted with inserted-tooth cutters for milling—at the next station—the front end face of the casting, to produce a flange thickness of $\frac{7}{16}$ in., and the power take-off face at the rear, to give an overall length of 34·000/34·005 in. A 20-in. diameter, 48-blade cutter, running at 45 r.p.m., is used for machining the front face, and the rear face is milled with a 14-in. diameter, 34-blade cutter, which runs at 56 r.p.m. The spindle quills first feed in to depth, and the bridge is then traversed hydraulically along the bed at a feed rate of 13 in. per min. Upon completion of the operation, the quills retract, and the bridge returns rapidly to the starting position.

The next station—No. 3—is idle, and at station No. 4, right- and left-hand vertical heads are fitted for drilling and reaming two location holes of 0·625/0·626 in. diameter, one at *g*, Fig. 1, in the hydraulic lift cover face, and the other, at *h*, in the centre yoke boss. A view of the right-hand head at this station, showing a loaded platen fixture in position, is given in Fig. 10. The heads are of similar design, and each carries a vertical slide *A*, fitted with two spindles which are mounted in a quill. The latter is arranged to index automatically through 180 deg. after the slide has completed one stroke, and it carries a $\frac{21}{32}$-in. diameter drill and a $\frac{5}{8}$-in. diameter reamer, which are guided in a spring-loaded sliding bush block *B*. Location for the bush block is provided by two dowels which enter holes in the fixed plate *C*, carried on support bars between the two columns. The limit switches which control the quill indexing are seen at *D*.

The last working station (No. 5) provides for milling the inside faces of the outer yoke bosses *j*, Fig. 1, by a right-hand head fitted with a horizontal milling spindle carrying two 8-in. diameter, side and face cutters. Each of these cutters is fitted with 12 tungsten-carbide-tipped blades, and the operation is performed at a speed of 90 r.p.m., with a feed of 4$\frac{3}{4}$ in. per min. At this station, a left-hand head, fitted with a compound slide, mills the boss seen in the drawing, Fig. 2, on the inside bottom face of the casting, to the dimension 15·043/15·038 in.

Referring to Fig. 11, after the operations have been completed in the first machine section, the fixture is indexed on to a wheeled trolley as seen at *B*, in preparation for unloading and transfer of the casting to the next section, on the left. Unloading is effected by means of a forked arm *C*, Fig. 12, which is pivoted in the head *D*, Fig. 11, and is swung through 180 deg. by a hydraulic motor. The head *D*, in turn, is mounted on a pillar, and is raised hydraulically, to lift the casting vertically out of the fixture, before the arm swings over to the left. In the neutral position, the arm is located vertically, as seen in Fig. 12.

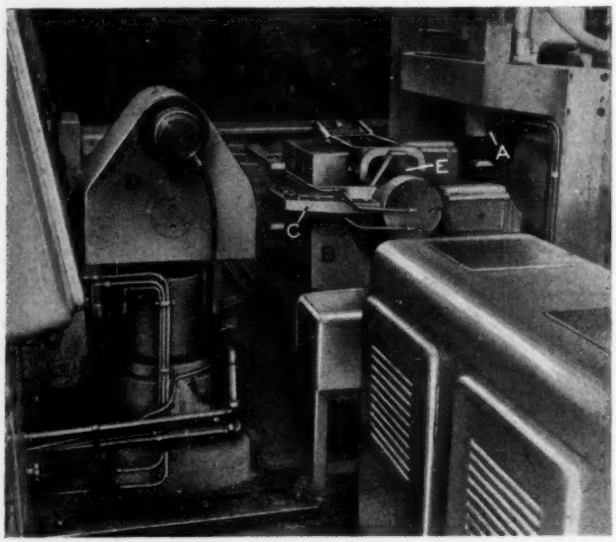


Fig. 11. The First Unloading and Transfer Station on the Heller Machine

After the arm has swung down to the right, gripper pads *E*, operated by hydraulic cylinders on the forks, engage the casting at each end, as shown, and the hydraulic ram at *A* then moves down to unlock the fixture clamps in the manner already described. The arm now moves upwards, swings to the left, and moves down again to deposit the casting, bottom face upwards, on the fixture at the starting end of the second machine section. Meanwhile, the empty fixture and trolley in the

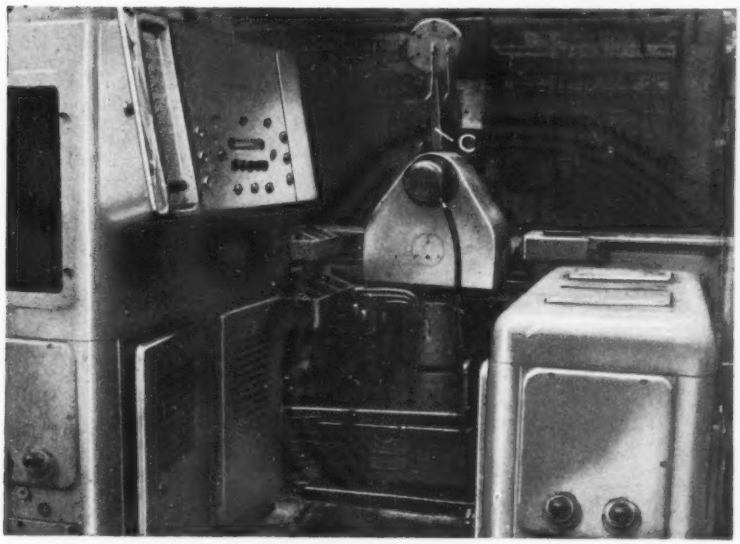


Fig. 12. Another View of the First Unloading and Transfer Station, Showing the Pick-up Arm in the Vertical Position

first section have been moved along the transverse runway to the rear of the machine. Here, the fixture is removed from the trolley and traversed along rails back to the starting end, as previously explained.

OPERATIONS IN THE SECOND SECTION

The fixture platens for the second section are of simple design, and each is provided with four seating pads for the machined hydraulic lift cover face of the casting, and two locations dowels which engage the previously-reamed holes. A fixture is seen at *A*, in Fig. 13, which is a view at the first working station, the loading position being to the right. Clamping of the casting *B*, at each station, is effected by a hydraulically-operated, 4-point rocker clamp *C*, which is carried in a fixed bridge member and is released at each cycle to allow the platen to index.

There are four working stations in the second section, and the operations carried out are concerned mainly with the power take-off shaft bore and the drive pinion shaft bores. For this reason, a centre block *D* is provided on each platen fixture, and is fitted with two guide bushes to support piloted boring bars, as at *E* and *F*. This bush block passes through the large rectangular cored hole in the centre housing.

At the first station, the bottom face of the casting is machined to the 7·670/7·665 in. dimension, by a left-hand vertical head, which is arranged to be moved, transversely, and is fitted with an 8-in. diameter face milling cutter, as seen at *G*. The cutter has 20 tungsten carbide-tipped blades and runs at a speed of 112 r.p.m., the feed rate being 6½ in. per min. The right-hand head is fitted with the two tool bars *E* and *F*, for rough and semi-finish boring the inner power take-off bore to 2·48 in. diameter, and rough and semi-finish boring the stepped pinion shaft bore to 2·42 in. and 4·23 in. diameter. Chamfering tools are also fitted to these bars.

Piloted, out-feeding facing heads, on the left at the next station, rough machine the front faces of

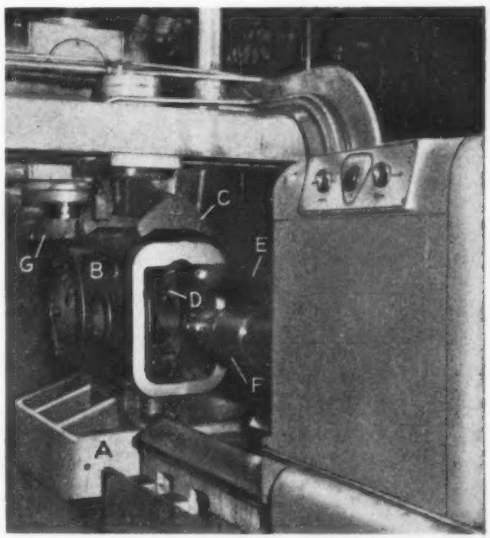


Fig. 13. A View of the First Working Station in the Second Section of the Heller Machine, Showing the Method of Locating and Clamping the Work, and the Pilot Block for Boring

the power take-off and drive pinion bores, and, from the right-hand side, the stepped outer bore for the take-off shaft is rough machined to 3·13 and 2·93 in. diameter, and chamfered. Only a left-hand head is provided at the third station, at which the bore faces are finish machined to the 8·374/8·376-in., and 13·188/13·192-in. dimensions. Finally, right- and left-hand heads at the fourth station finish machine the stepped pinion shaft bore, and the front and rear power take-off bores, to the dimensions shown on the drawing.

SEQUENCE OF OPERATIONS IN THE THIRD SECTION

As in the case of the first machine section, the platen is indexed, at the finishing end of the second section, on to a trolley and the casting is unloaded. The empty platen is then automatically transported back to the starting end along a runway system. For the third series of operations, the casting is turned anti-clockwise through 90 deg. and loaded on to the platen in the position shown in Fig. 14. Location is again taken from the two reamed holes provided for this purpose, and clamping is effected from above by means of a 4-point, hydraulically-operated rocker clamp, in the same manner as in the second machine section. The clamp at one of the working stations can be seen at *A*, in Fig. 15. Safety micro-switches

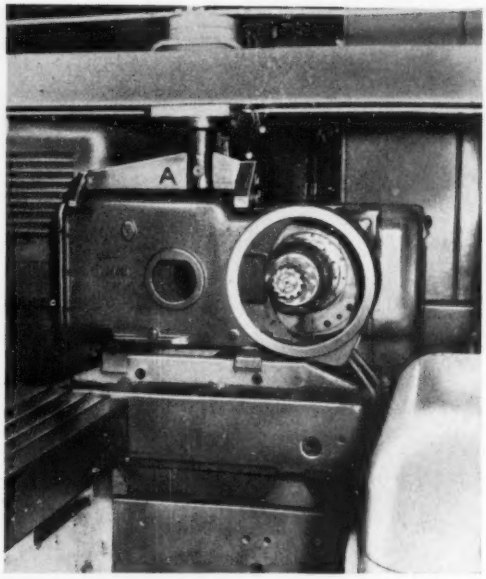


Fig. 15. The Station in the Third Section of the Machine which Provides for Milling the End and Side Faces of the Pinion Shaft Bearing Boss

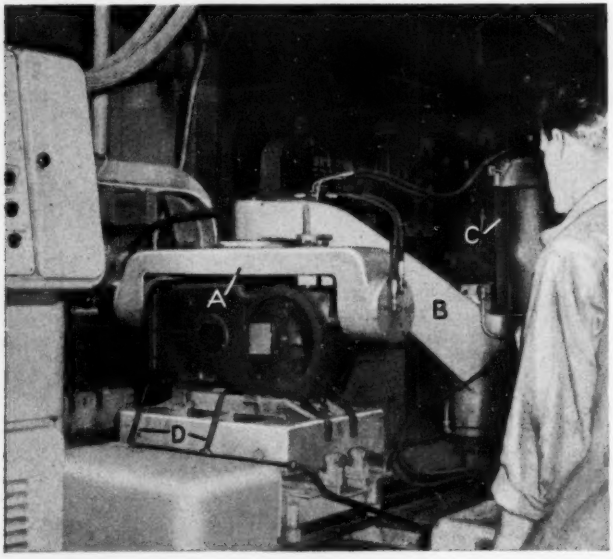


Fig. 14. Equipment for Transferring the Casting to the Third Section of the Heller Transfer Machine

on all the clamps ensure that the operating sequence is correct.

The unloading and transfer mechanism between the second and third sections is of the same design as that at the finishing end of the machine, seen in Fig. 16, where the completed casting is loaded on to a slat conveyor for movement to the Archdale Unimatic transfer machine. Referring to Fig. 14, the casting is gripped at each end by hydraulically-operated pads in the fork member *A*, which is carried on the outer end of the arm *B*. The latter is raised and lowered, by means of a hydraulic cylinder, on a pillar *C*, which, in turn, is rotated about a central mounting by a hydraulic motor. The seating faces on the platen are cleaned by means of air jets, as at *D*, before the workpiece is loaded, and it may be noted that a similar precaution is taken when loading for transfer through the second section. In Fig. 16, a casting is about to be lifted from the platen and moved to the

left on to the adjacent slat conveyor.

The first working station provides for rough and semi-finish boring and facing the 13·188/13·192-in. diameter spigot bores in the side of the casting, which carry the rear axle housings of the tractor. These operations are performed at a spindle speed of 70 r.p.m., with a feed rate of 0·007 in. per rev. for boring, and 0·014 in. per rev. for the out-feeding facing tools. The same speeds and feeds are employed at the next station, at which right- and left-hand spindle heads are applied for finishing the spigot bores, and facing the casting to the 8·953/8·951 in. width dimension.

Only a left-hand horizontal head is provided at the third station, for machining the inside of the casting to afford clearance for the main drive crown wheel, and another head on the left, at the fourth station, mills the end and side faces of the boss *K*, Fig. 1. This head, seen in Fig. 15, carries a horizontal spindle fitted with a 3½-in. diameter slab milling cutter, and a 5½-in. diameter side and face cutter, both of which are carbide tipped. The spindle is mounted in a quill, which is advanced transversely to the cutting position at the start of the operation. A vertical feed is then applied to the head, and the end and side faces of the boss are machined. Adjustment for cutting depth, when setting up the machine, is obtained by means of an eccentric mounting for the spindle quill. Finally, at the fifth working station, the 6½-in. diameter side pads *l*, Fig. 1, are milled to a width of 3·98 in. by means of right- and left-hand horizontal spindle heads, each carrying a 10-in. diameter cutter with 26 tungsten carbide-tipped blades.

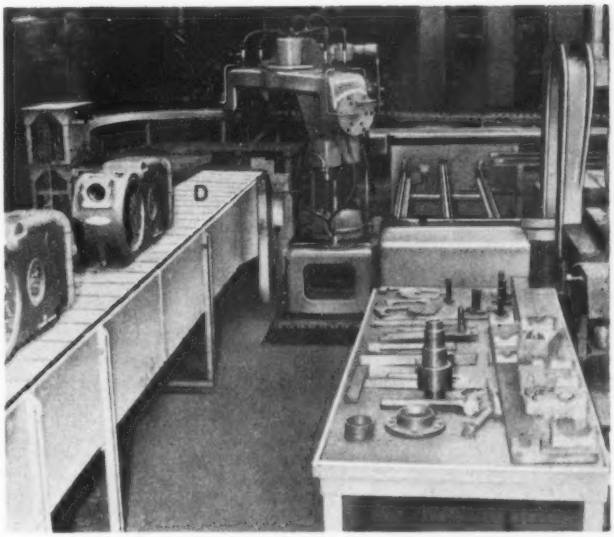


Fig. 17. A General View at the Unloading End of the Heller Machine. The Slat Conveyor at the Left Leads to the Archdale Transfer Machine

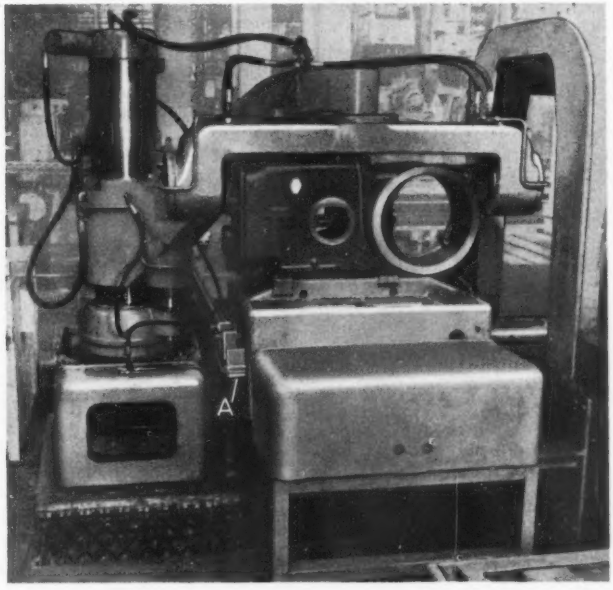


Fig. 16. Unloading a Finished Casting at the End of the Third Section

Reference has already been made to Fig. 16, where a finished casting is seen being unloaded from a platen, which has been indexed out of the machine on to a wheeled trolley A. The latter, with the empty platen, is then transported along the transverse rails to the rear. A general view at the unloading end is given in Fig. 17. After a casting has been deposited

by the hydraulic unloader on to the slat conveyor *D*, the latter is automatically indexed forward to provide a space for the next. Castings are transferred from the outlet end of the conveyor to the Archdale Unimatic machine with the aid of an electric hoist, and a safety limit switch is fitted which prevents the hydraulic unloader from operating should no space be available on the conveyor. The castings are inspected at this stage, and some of the gauges employed are seen on the table on the right.

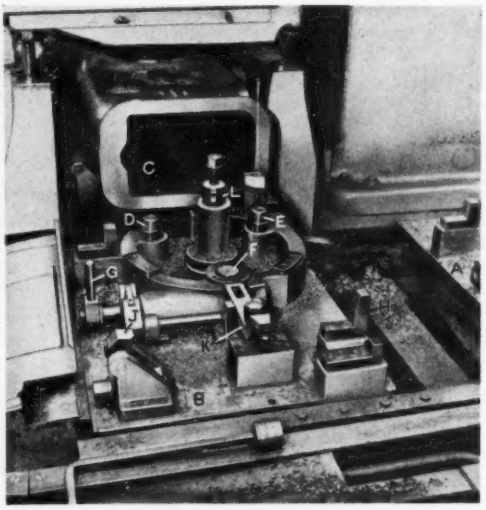


Fig. 19. The Platen Fixture Employed for the First Series of Operations Performed on the Archdale Machine

ARCHDALE UNIMATIC TRANSFER MACHINE

The Archdale transfer machine is designed to complete, at two stages, all the drilling, tapping, countersinking and reaming operations required on the casting. In all, there are 98 holes, 77 of which are tapped. There are two machine sections, and the work is reversed and turned through 90 deg. when it is loaded into the second section In general design, the machine resembles others supplied to the company for machining transmission housings and other tractor components, as already described in MACHINERY. Platen-type fixtures are employed, which, after they have been unloaded, are returned to the starting ends of the sections by means of floor-mounted chain conveyors at the rear of the main beds. The conveyors are located immediately alongside the beds and pass through apertures in the transverse bed extensions which support the various spindle heads. This arrangement has the advantage that no additional floor space is required for the conveyors.

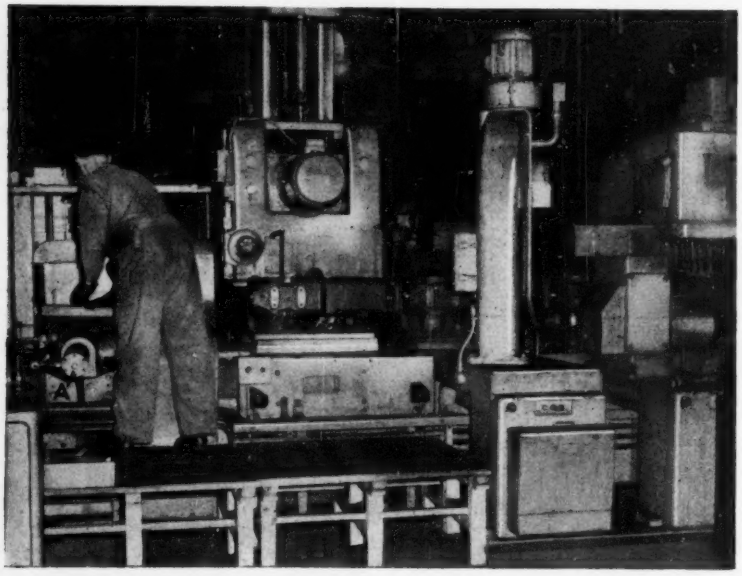


Fig. 18. A View at the Finishing End of the First Section of the Archdale Machine

A general view of the finishing end of the first section is given in Fig. 18, and the starting end is seen in Fig. 19. Empty platens are deposited by the rear return conveyor on a hydraulic table which lifts them automatically to the position shown at *A*. When the start cycle button is pressed, the platen at *B*, loaded with a casting, is indexed to the first working station *C*, and a hydraulic ram at the rear then pushes the platen *A* to the forward position in preparation for loading another casting.

In the first section, the casting is loaded

bottom face towards the operator, and with the rear end in the direction of flow, as may be seen at *C*. Location for the work is taken from the 13·188-in. diameter spigot bore, which passes over two fixed pins *D* and *E*, and a sliding pin at *F*. To facilitate loading, the latter pin can be retracted, as shown, by means of the hand lever *G*, through a pinion and rack. Sideways location is provided by a stop *H*, against which the machined top face of the casting is held by the application of a pivoted clamp *J*. Movement of the lever *G*, to raise the location pin, also advances the toe clamp *K* into engagement with the casting, and the clamp is then tightened with the aid of a box spanner. Additional support is provided against the cut by a 3-arm spider which is tightened by a nut and C-washer on the pillar *L*, and bears on the top spigot face of the casting.

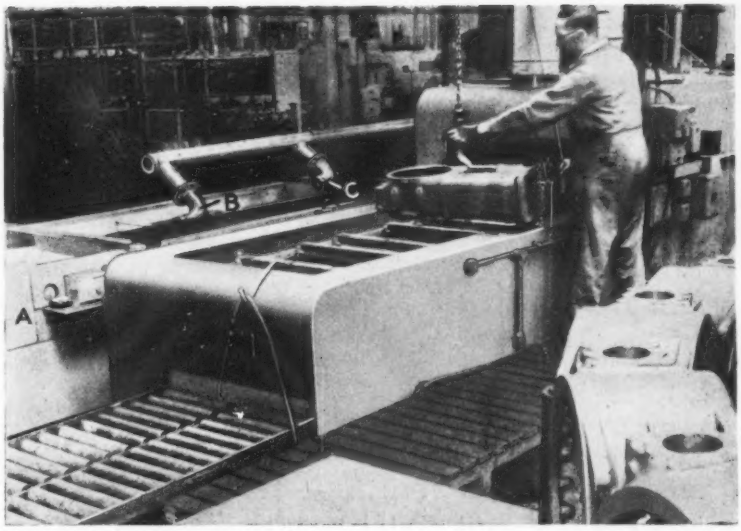


Fig. 21. The Curran Conveyor Type Washing Machine. A Philips Filter Paper Clarifier is Provided for the Cleaning Fluid

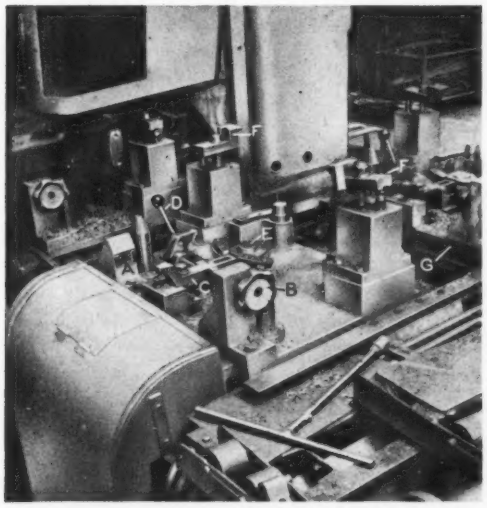


Fig. 20. A View of the Platen Fixture for the Second Series of Operations on the Archdale Unimatic Transfer Machine

There are eight working stations in the first machine section, and at three, the heads provided are fitted with combined depth gauges and air jets, for the purpose of removing swarf from holes that are to be tapped at adjacent stations. The operator in Fig. 18 is seen unloading a casting, which is deposited, with the aid of an electric hoist, on a gravity roller conveyor to the left. A hydraulic ram at *A* then pushes the empty platen back on to a hydraulic table, which moves down to allow the platen to be picked up by the return conveyor chain.

The starting end of the second machine section is shown in Fig. 20. Here, the casting is positioned transversely, with the flanged end outwards. Location is again provided by two fixed pins and one retractable pin in the spigot bore, and the hydraulic cover face is held against a stop *A* by the screw *B*. A toe clamp *C*, moved into position by the lever *D*, which also actuates the retractable location pin at *E*, is fitted. Instead of a clamping spider, there are two toe clamps *F*, which engage the outside of the casting. Another platen is seen at *G*, on top of the hydraulic lift table.

Finished castings, unloaded from the machine with the aid of an electric chain block, are delivered to the Curran conveyor-type washing machine shown on the floor plan, Fig. 3, also in Fig. 21.

The cleaning cycle is initiated by push-button, and the casting remains in the washing chamber for a pre-set period, determined by an electric timer. At the end of this period, the conveyor is automatically indexed and the casting is removed and placed on an adjacent inspection table for checking, before it is loaded on to the main shop conveyor for delivery to the tractor assembly line.

A feature of interest in connection with the washing unit is the provision of a Philips clarifier, of the travelling filter paper type, for the washing fluid. The clarifier is located alongside the cleaning unit as seen at *A*. Fluid from the supply tank of the unit is pumped, by way of the pipes *B* and *C*, into an upper distributor tray on the clarifier. This tray measures about 9 ft. by 2 ft. and has a perforated bottom plate so that the fluid flows evenly on to the filter paper beneath. The paper is supported on a broad, wire mesh belt, arranged to form a trough, and when the fluid level rises beyond a predetermined point, because of the reduced rate of flow through the filter, a ball valve actuates a micro-switch, to start a small motor which brings a fresh length of paper to the working position. The pump employed, supplied by Girdlestone Pumps, Ltd., has a capacity of 390 gal. per min., and is driven by a 10-h.p. motor.

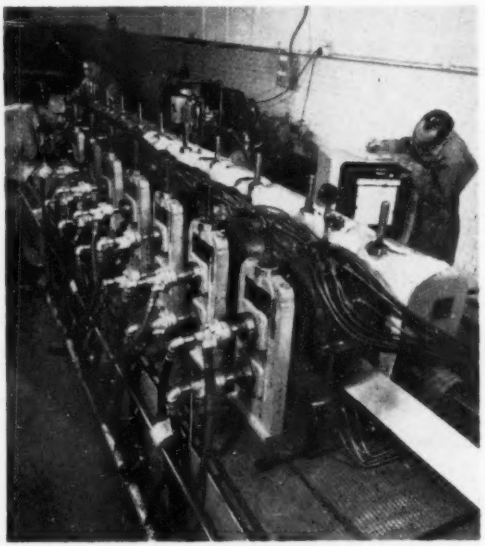
The cycle time for the complete series of operations on the Heller and Archdale machines is approximately 100 sec. The Heller machine was designed to be tended by one operator, but in addition to the operator at the loading end, two patrol operators are at present employed, together with two tool setters. It may be noted that a push-button control station is provided for each section of this machine. Four operators are required for the Archdale installation, for loading and unloading the castings at each section, and there are two tool setters.

For handling swarf from the various in-line transfer machines employed for tractor components, an under-floor pneumatic system has been installed by the company in collaboration with the Midland Heating & Ventilating Co., Ltd. Some details of this system, which is stated to represent a new development, have already been given in MACHINERY, 91/135—19/7/57. Swarf from the Heller three-section machine falls down chutes at the various stations directly into the floor duct, whereas on the adjacent two-section Archdale machine the swarf is carried by drag-link conveyors to pits which are connected to the ducting.

Machine Adapted for Hot Roll-forming Titanium

To enable the possibilities of roll-forming titanium at elevated temperatures to be investigated, a Yoder machine has been modified at the works of the Boeing Airplane Co., U.S.A. Furnaces were designed and constructed to enclose each set of rolls as shown in the figure. There are 18 burners round the periphery of each furnace, and premixed propane gas from a standard combustion-control unit is used as fuel, the supply being controlled by a infra-red sensing device which ensures that the required temperature is maintained.

In operation, the rolls are at a dull red heat, and hollow shafts have been provided through which cooling water is circulated. It has been found that a temperature of 1,000 deg. F. is satisfactory for roll forming. For most of the tests carried out so far, 8-ft. long strips have been employed, but one 32-ft. strip has been successfully processed. A speed of about 1½ ft. per min. was adopted for the tests, but it is believed that much higher speeds will be possible.



Yoder Machine Adapted for Hot Roll-forming Titanium Strip. Propane-fired Furnaces Surround Each Roll and Maintain it at Dull Red Heat, the Roll Shafts being Water-cooled

Autronic Electro-magnetic Clutch and Brake Units

The field of application for the patented Autronic magnetic clutch and brake units, which are now being made by Newport Instruments (Scientific & Mobile), Ltd., in association with Autronic Developments Ltd., Newport Pagnell, Bucks., has been considerably extended since they were introduced some 10 years ago. These units can be supplied with disc elements from as small as 1-in. up to 9-in. diameter, which provide static torque capacities from 30 oz.-in. to 396 lb.-ft. The smaller sizes are being employed, for example, in computers and control instruments for various purposes, including guided missiles, while the larger sizes, it is stated, are finding applications in machine tools and many other types of industrial equipment. A number of important advantages are claimed for the units, among which may be noted high torque capacity in relation to size, very smooth yet rapid engagement, and the possibility of accurately controlling torque.

In its simplest form, a clutch or brake comprises three principal parts, namely, a magnet disc with an annular recess which accommodates the winding, a plain armature disc, and, between the two, a thin floating plate. Double-type clutches for reversing and change-speed duties have five components, as shown in Fig. 1, namely two magnet discs *A*, the armature disc *B* and two floating plates *C*. An assembly is shown in Fig. 2.

The magnet and armature discs are made from a special iron with non-residual magnetic properties, and the contact faces are surface hardened, and ground and polished, so that they are flat to very close limits and have a high finish. For the floating plate, which may be slotted, as indicated at *x*, to ensure close contact with the magnet and armature, a high-permeability alloy is employed, and the surfaces are phosphate-treated to provide anti-scuffing properties. The D.C. electrical supply, normally at 12 or 24 volts for units up to 3¼-in. diameter, and 24 volts for the larger sizes, is fed to the coil by way of a hardened-steel, polished slip ring *y*, on the magnet disc, and a hard copper-graphite brush, which makes contact with a fairly high pressure. A continuous service life of two to three years is stated to be common for this type of brush, when correctly bedded.

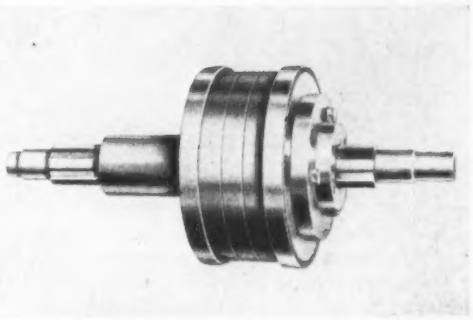


Fig. 2. The Rotating Assembly of an Autronic Double Electro-magnetic Clutch and Brake Unit

With this arrangement of a magnet, an armature, and a thin floating plate of high permeability, maintained in close contact without air gap, the magnetic losses are reduced to the lowest possible amount, and they are constant under all operating conditions. For any particular size of unit, therefore, the dynamic rating provided by the energizing current is relatively high, and, in service, no

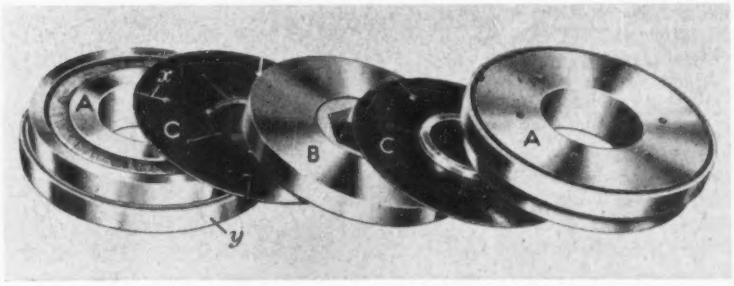


Fig. 1. Components of an Autronic Double Clutch Assembly

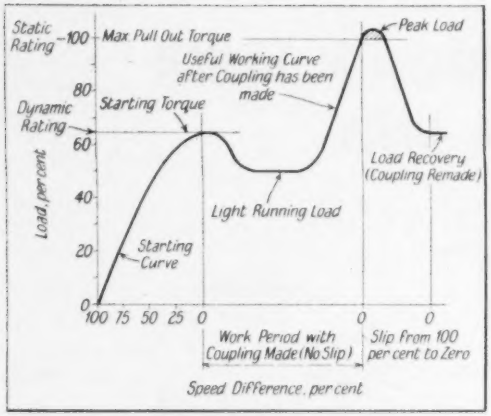


Fig. 3. Operation Curve for an Autronic Clutch Unit, During Starting, Running, and Overload

adjustments whatever are required to maintain efficiency. The units, moreover, are designed, to run immersed in oil, or with oil mist lubrication, which, in conjunction with the highly-polished contact surfaces, results in very low friction, and provides for cooling. (Shell Tellus grade 41 or 33 oil is recommended.) This feature enables suitably rated units to be operated continuously under conditions of controlled slip, which is often necessary for particular types of drives. If the use of oil is not permissible, the units can be operated with dry lubricants, for example, colloidal graphite or molybdenum disulphide.

When the clutch is fully engaged, the dynamic rating provided by the energizing current is stated to contribute 65 per cent of the total torque capacity, the remaining 35 per cent being attributable to static friction between the contact faces. The co-efficient of friction, however, is much reduced when there is relative rotational movement between the elements as the drive is being taken up, or when slipping occurs due to overload, since the faces in contact are lubricated and purposely finished to a high degree of smoothness.

Under conditions of slip, therefore, practically the whole of the torque is transmitted electromagnetically, and the drive is taken up very smoothly yet rapidly even when the clutch is engaged under full load conditions. Heat due to energy loss, moreover, is generated, and dissipated, throughout the entire unit, and not locally at the contact faces as in those types of clutches where reliance is placed wholly or largely on friction for the transmission of torque. It is stated that no temperature rise above ambient results from slip during short periods of overload. On the other hand, units have been operated continuously under conditions of controlled slip, at temperatures up to 100 deg. C., without damage. Another advantage claimed for the design is the consistency of the holding torque. Provided that a clutch of suitable rating is used for a particular application, the load at which slip occurs is only a little higher than the permitted operating torque, and there is a smooth and rapid return to the original working torque immediately the overload is removed. Fig. 3 shows the operation curve for an Autronic unit during starting, running, and overload. There is no residual drag when the magnet is de-energized.

Dynamic torque capacity is directly proportional to the magnetizing current, and control is readily effected, remotely if required, through a rheostat or other electrical arrangement in the coil circuit. The maximum current consumption is fairly low and ranges from 350 milliamp. for the 1-in. size, operating on 12 volts, up to 3 amp. for the 9-in. size, which operates on 24 volts. Units designed for other voltages can be supplied to meet special requirements.

Various types of standard units of compact design, suitable for operation at speeds up to 3,000 r.p.m., are available which can readily be incorporated in existing machines. Fig. 4, for example, shows the type F unit which can be supplied in sizes from 2¾- to 7-in. diameter. With a single disc arrangement, these units can be employed as simple driving clutches, slipping clutches to provide variable speeds, and as brake units of

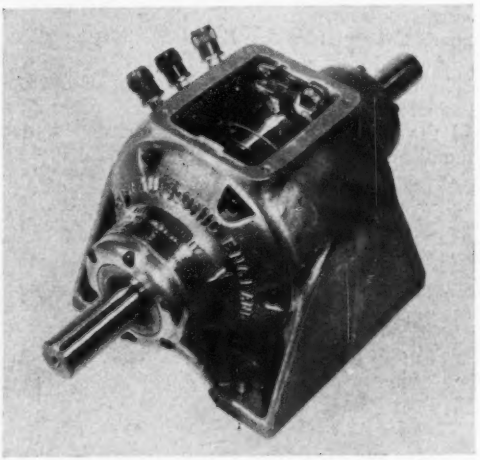


Fig. 4. A Type F Standard Autronic Clutch and Brake Unit

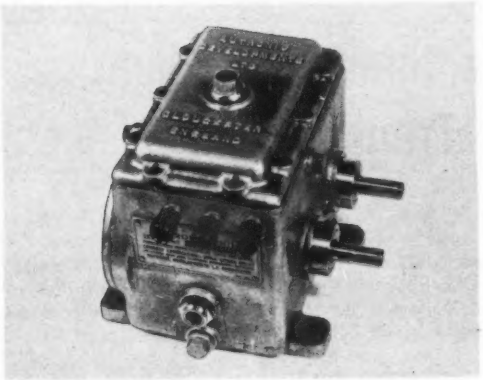


Fig. 5. Autronic Reversing and 2-speed Gearbox

fixed or variable retarding capacity. When fitted with double discs, such a unit finds useful application as a combined clutch and brake, or a twin clutch for engaging high and low speeds, or for reversing, under push button or automatic control. The facility with which the torque capacity can accurately be varied by rheostat also enables the unit to be employed with advantage as a safety clutch which comes into operation immediately a specified torque is exceeded, and does not require re-setting.

Reference may also be made to the Autronic reversing and 2-speed gearbox, Fig. 5, which is being marketed to meet the demand for a small, compact unit suitable for automatic control. The input and output shafts, of ½-in. diameter, are parallel to each other, and the unit can be fitted with double discs of either 2¾-in., 3¼-in., or 4-in. diameter, to give dynamic torque capacities of 8 and 12 lb.-ft. Gear ratios from 1 to 1 up to 2 to 1 can be provided in the standard units, and the output shaft may run in reverse, or in the same direction as the input shaft. The frequency of operation may range up to 60 times per min. Larger units can be made to meet special requirements, and single- and double-disc assemblies in all sizes can be supplied separately, for incorporation directly in the drives of machine tools or other types of equipment. Speeds of operation very much higher than the 3,000 r.p.m. recommended for the standard units can be employed if the rotating parts are dynamically balanced to a suitable degree of accuracy, and account is taken of the accelerating and decelerating torques imposed, when determining the ratings.

In the machine tool field, it may be noted that Autronic clutches are being employed with advantage in jig boring machines, production lathes, milling machines, gear grinders, capstan and turret lathes, and a variety of special-purpose machines as used, for example, in the motor-car industry.

Solders with Higher Copper Content

Normally, the amount of copper which is present in solder is limited to 0·08 per cent, the object of this restriction being to prevent the formation of gritty crystals of tin-copper compound which affect the free-flowing and penetrating properties of the solder. These properties are very important in dip-soldering applications. On the other hand, it is known that by reason of this small copper content, molten tin and solder will attack a copper soldering-bit, and will dissolve the working point in an irregular manner, particularly if a strong chloride flux is used. Various attempts have been made, in the past, to overcome this disadvantage, for example, by reducing the soldering temperature; making the soldering-bit of an alloy, or metal, which is resistant to the action of tin; and coating the bit with a thin layer of iron. However, each of these methods has its particular disadvantages, and only the last mentioned is really successful.

A report published in the quarterly journal of the Tin Research Institute describes a series of experiments which have been carried out by Dr. Gunther Laubmeyer.* Stick and wire-form solder was used, with a copper content of as much as 1½ per cent by weight. The tin-copper compound was present in a very fine crystalline form, and as the solder was already "saturated" with copper, there was no appreciable tendency for it to attack the bit. Moreover, the presence of this additional copper is claimed to increase the fatigue and creep strengths of the joint, and the corrosion resistant properties of the solder are not affected.

High copper content solders are now available from a number of licensees in several countries, and are the subject of British patent 721,881.

MAGNETIC/OPTICAL FILM PROJECTOR.—A new G.B.-Bell & Howell projector, it is stated, enables sound films to be produced quickly and cheaply in any language. Background noises are recorded directly from the optical sound track on to a magnetic track, and a commentary is added in whatever language is required. This commentary may be subsequently erased, and another substituted, without affecting the background noises.

* Zeva Electrizitäts Ges., Arolsen/Waldeck, Germany.

Gear Production for the Buick Flight Pitch Dynaflow Transmission

A feature of the 1958 Buick car is a new transmission known as the Flight Pitch Dynaflow, with a 5-element torque converter which incorporates three turbines. Two of the turbines are connected to the output shaft through planetary gear sets, and the third is connected directly to the shaft.

A multiple-pitch stator, in which the angular positions of the blades are steplessly variable, is another innovation. The angle of the stator blades depends on the throttle opening, and the arrangement is such that the optimum combination as regards over-all performance and economy is ensured.

Gears required for the Flight Pitch transmission are being manufactured at lower cost and higher production rates as a result of the adoption of completely automatic processing. Mr. Frank Albro, master mechanic for Buick, has played a leading part in the development and installation of various automatic gear-production lines.

A good example of such a line at the Buick works is that provided for the rear-driven pump gear. Blanks for these internal gears are cut off from SAE 1018 or 1112 seamless steel tubing on multiple-spindle bar automatics. The blanks are 3·403 in. diameter by 0·391 in. wide and have a 2·518-in. bore diameter.

After they have been manually loaded into baskets for a stress-relieving heat-treatment, the blanks are completely processed, through grinding, turning, boring, broaching, deburring, inspection, and classification, on an integrated line shown diagrammtically in Fig. 2, which is controlled by a combination of electrical and mechanical systems. In addition to self loading and unloading equipment, work elevating and storing units are provided to balance out slower and faster operations. This arrangement also permits of shutting down certain machines in the line for maintenance, repair, or tool changes, without the need for interrupting operation of the remainder of the line.

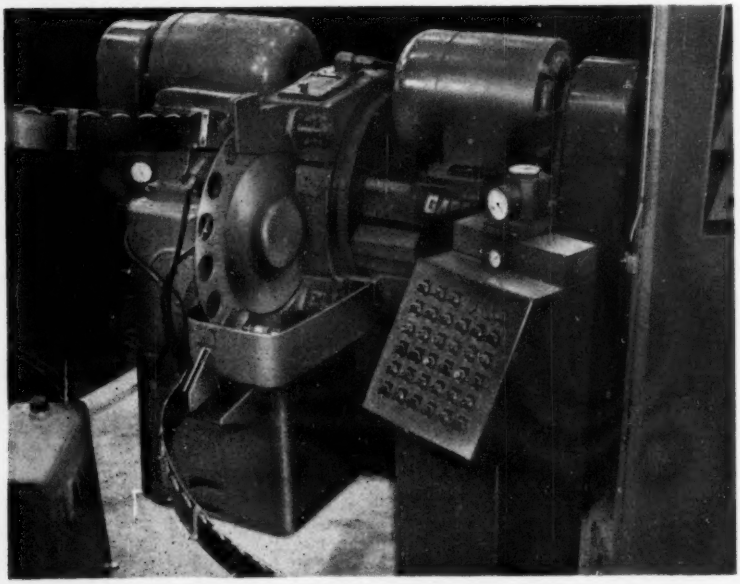


Fig. 1. Gear Blanks are Mechanically Loaded from a Chute (upper left) into the Rotary Work-carrier of this Duplex Grinding Machine

The entire materials-handling system was designed and built by the F. Jos. Lamb Co., Detroit, Mich., U.S.A. It comprises 14 elevators, seven storage units, one special sorting and elevating unit, and approximately 350 ft. of flexible chute. Electrical controls for this system are independent of the electrical controls on the individual machines and gauges in the line. With this arrangement, easier and faster maintenance is permitted, and any portion of the system can be operated independently. It also makes possible the addition or deletion of machines if the product design is changed.

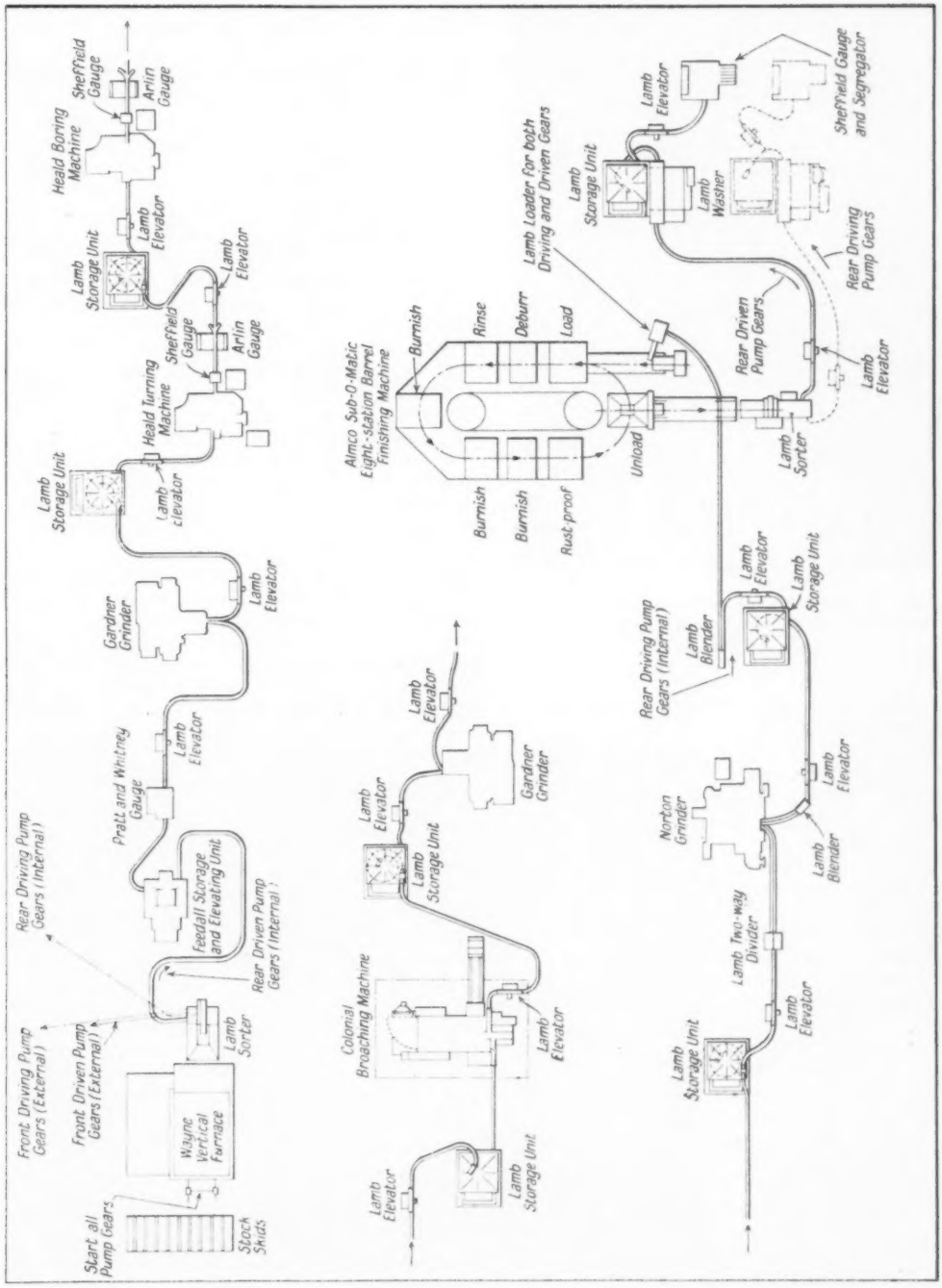


Fig. 2. Layout Diagram of a Production Line for Internal Gears at the Buick Works

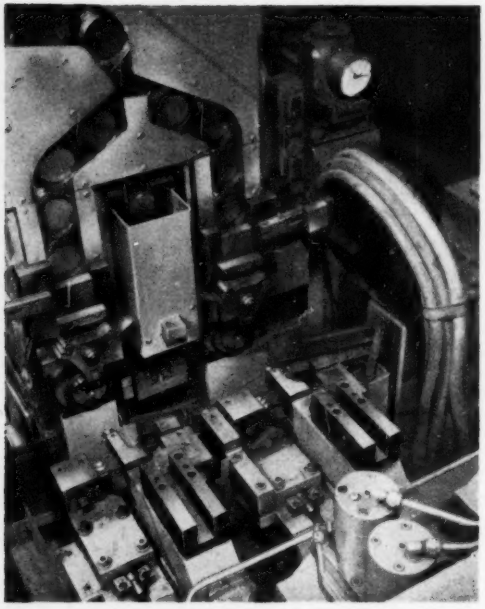


Fig. 3. Tools are Adjusted Hydraulically under the Control of a Feedback Gauging System on the 2-spindle Borematic

The amount of storage capacity provided in front of each machine is based on the time required for normal tool or grinding wheel changes or adjustments, also on differences in machine production capacities. When a storage unit has absorbed its full capacity of parts, a signal is transmitted to the preceding elevator, and work flow is stopped. Through electrical interlocks, the flow of parts in the preceding materials-handling units is also stopped. The Lamb Fabriflex chute is made from tempered spring steel of suitable size.

Balance-type switches are used to control input to the various machines. When a machine has been filled, parts in the chute accumulate on a balance bar of the switch assembly and depress the bar slightly. This movement actuates a limit switch and stops the flow of parts. When the machine again accepts parts and the balance bar is cleared, it returns to its normal off-contact position, and the flow of parts is resumed. Signal lights indicate the all-clear or non-operating condition for the various units.

Stress-relieving is carried out in a Wayne vertical furnace at a temperature of 1,100 deg. F. In addition to the blanks for the rear-driven pump gears, blanks for three other pump gears (two external and one internal) are loaded at random into the furnace. After the stress-relief treatment, the baskets containing various blanks are automatically dumped into a Lamb part-sorting unit. This unit separates the blanks according to diameter and width, and delivers them by means of chutes to elevators. All the Lamb elevators incorporate standard chains with attachments, spaced approximately 12 in. apart, to which are fastened pick-up fingers for raising the parts. The elevators have ball-and-socket type drive clutches arranged for spring release in the event of jamming. From the elevators, the blanks roll down chutes to Feedall bulk storage and elevating units located at the starting ends of the gear-production lines.

Before they are machined, the blanks are inspected for thickness and diameter by passing them through a Pratt & Whitney gauge. Parts not within the required limits of $\pm 0{\cdot}008$ in. are automatically rejected. Acceptable blanks are again elevated and fed by chute to the Gardner double-spindle, disc grinding machine seen in Fig. 1. Here, the sides of each blank are ground parallel between the opposed, 30-in. diameter abrasive discs.

The blanks are transferred, one at a time, from the loading chute to an opening in the top of the 18-station, rotary work-carrier. Ground parts are ejected at the bottom into an unloading chute leading to another Lamb elevating unit. A total of 0·009 to 0·013 in. of stock is ground from the blank faces, leaving 0·0025 to 0·0065 in. for removal at a subsequent finish-grinding operation.

For size control, a Sheffield dual open-jet system and a single Plunjet and gauging anvil sizing attachment are employed. A Lectrolair feed-in machine-control unit advances the abrasive discs towards each other, when required, to compensate for wear. Cluster-type diamond dressers, which are operated by a combined air-hydraulic system, periodically true the abrasive discs. Blanks are fed to the grinder in accordance with demand. Coolant is introduced to the grinding areas through the two hollow spindles of the machine, and a Barnesdril magnetic separator is provided for removing swarf prior to re-circulation.

Rough-ground blanks roll down a chute from the elevator into the top of a Lamb spiral storage unit. This particular unit is equipped with two circular tiers, or decks, and will accommodate about 800 blanks. Parts roll into the centre of the top tier of the unit and travel through a spiral track (carried by a drive plate) to the outer edge of the tier. From this point, the blanks pass by gravity chute to the centre of the next tier directly below. The banking units can be provided with from one to five tiers, depending on the amount of storage required. Two drive speeds are available,

and the lower speed is employed for storing parts when the requirements of the machine are satisfied, or it has been stopped for servicing. The higher speed is engaged to carry the parts rapidly through the unit, when necessary, to satisfy machine demand.

From the bottom of the storage unit, the parts are again elevated and roll down a chute to the Heald 2-spindle, single-end, Borematic (Fig. 3), set-up for precision turning. On this machine, the blanks are turned to a diameter between 3·388 and 3·389 in. (about 0·015 in. of stock being removed), and both ends of each blank are chamfered 0·018 in. at 45 deg.

The single column of parts fed to this machine is divided in two, so that there is one column above each spindle, by means of a special loading mechanism designed by the Heald Machine Co. and Mr. Frank Albro. A loading arm moves up and down, as well as in and out, to transfer two parts at a time from the overhead chutes to the spindles, which are equipped with air-operated, rotating-stake fixtures for gripping the blanks. Triangular carbide inserts are used for turning, and square carbide inserts for chamfering.

A Sheffield Lectrolair feed-back gauging system operates with two sets of limits. The wider set, which covers the full tolerance, is for rejecting parts. The second closer set provides for adjusting the tools to keep the parts within tolerance. For this purpose, the turning tools are moved towards or away from the workpieces, in increments of 0·0002 in. as required. This adjustment is effected by pivoting the tool-holder bars hydraulically. The gauging system also stops the machine automatically if two successive parts are produced which are outside the full specific limits.

Fig. 5. Internal Teeth are Broached in Three Blanks at a Time on this 20-ton Machine

Turned gear blanks are mechanically ejected, and roll down a chute into an Arlin electronic gauge, seen at the right in Fig. 4, which checks the chamfer. Unsatisfactory parts are re-

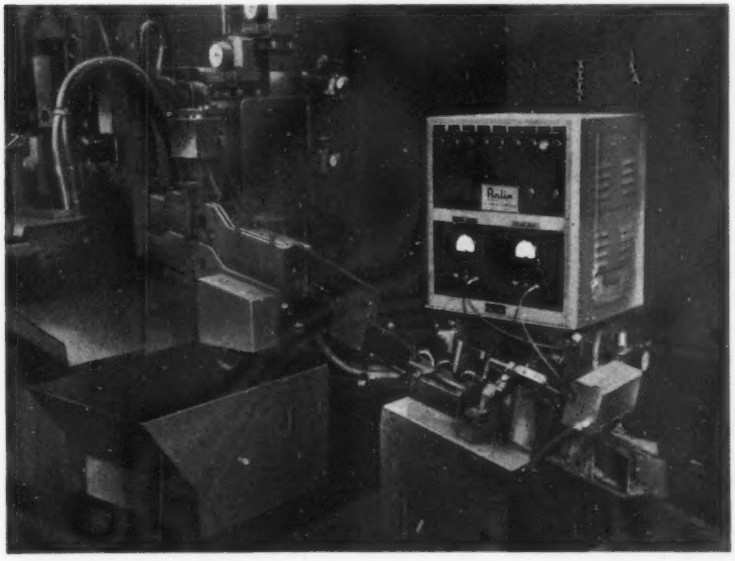


Fig. 4. The Electronic Gauge Seen at the Right Checks the Chamfers on Gear Blanks and Rejects Unsatisfactory Parts

jected, and acceptable blanks roll down another chute to an elevator and storage unit.

From the bottom of the storage unit, the blanks are again elevated and fed by chute to a second Heald 2-spindle, single-end precision boring machine. Here, the workpieces are bored to a diameter between 2·5325 and 2·5335 in. and both sides are chamfered 0·018 in. at 45 deg. From 0·0125 to 0·0175 in. of stock is removed from the bores. Loading, feed-back gauging, and tool compensation arrangements on this machine are similar to those on the preceding Borematic employed for turning.

Bored blanks are again elevated and pass through another Lamb spiral storage unit before being fed to the Colonial 20-ton, 66-in. stroke, pull-down broaching machine shown in Fig. 5. A special section of twisted chute (left) reorientates the parts from a rolling to a sliding position. Three parts are handled at a time, and the 27 internal teeth of each gear are broached to size, the diameter between tooth tips being held to 2·5420/2·5430 in. A nesting type shuttle fixture transfers a stack of three blanks from the loading chute to the broaching position.

After they have been broached, the gears are separated and fall on to a special "water-fall" chute, whence they are elevated into a storage unit having a capacity for 500. Samples of the broached gears are removed periodically and taken to the laboratory for a complete inspection. The gear faces are finished on another Gardner 30-in. double-spindle, disc grinding machine, with similar mechanical loading, sizing control, and unloading arrangement. Surface finish is held to a maximum of 20 micro-inches at this operation. Parallelism of the faces is maintained within 0·0005 in., and the surfaces are held square with the gear axis within 0·001 in. total indicator reading.

After being elevated and fed through another 500-part storage unit, the gears are mechanically loaded into the Norton 10- by 18-in.

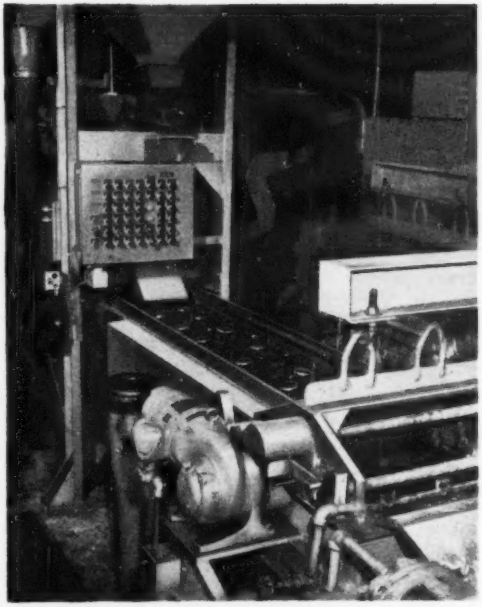


Fig. 7. Abrasive Chips and Workpieces are Loaded into the Barrel from a Conveyor on this Machine which Provides for Burr Removal

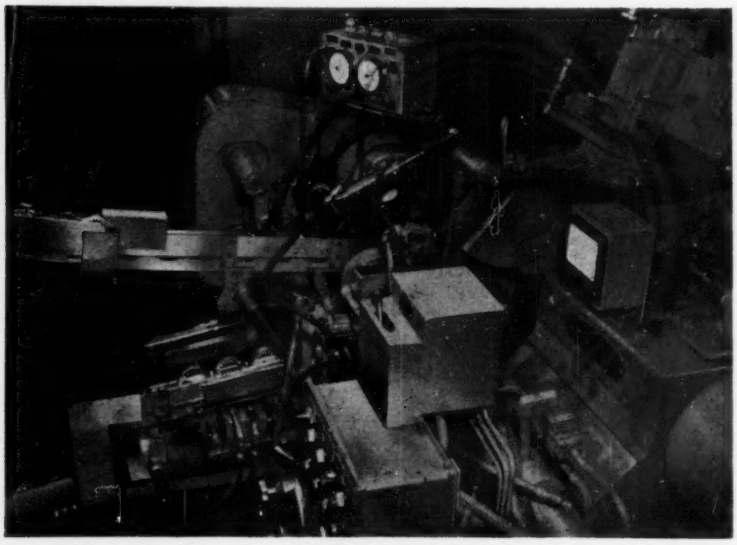


Fig. 6. The Outside Diameters of Two Gears at a Time are Finished on this Cylindrical Grinder

Fig. 8. One of the Lamb Spiral Type Storage Units Employed in the Gear-production Line

cylindrical grinding machine seen in Fig. 6. Here, the outside diameter of two gears at a time is finish ground, about 0·023 in. of stock being removed and a finish of 20 micro-inches maintained. Gears rolling from the loading chute are divided into two lines, each comprising an equal number of parts. This division is accomplished by means of a Lamb shot-bolt type, two-way Divider, controlled by a switch in each line. One gear from each line falls into one of three openings in a turret-type work-holder.

A special hydraulically-operated tailstock pushes the gears, two at a time, on to a Martin expanding arbor mounted on the live headstock spindle, and holds them in this position during the operation. When grinding has been completed, a spring-loaded ejector pushes the gears back into the rotary holder. After the holder has been indexed, the gears fall into unloading chutes. The two lines of parts pass through a blender, which re-positions them in a single line.

A straight-sided grinding wheel of 30 in. diameter by ⅞ in. wide is used. The machine is controlled by an Arnold continuous, caliper-type gauge with a Federal Electricator tolerance unit and electronic circuit. A Federal after-gauge, which checks the gears as they roll down the unloading chute after being ejected, provides compensation for size variations, and stops the machine if two unsatisfactory parts are produced consecutively.

Gears are again elevated and fed through a 2,000-piece storage unit before being deburred. At this point, the production line for the rear pump gears blends with that for the front pump gears. The two elevators, one for each line, have a common control panel, and only one operates at a time to elevate and feed a predetermined number of parts. Burrs are removed and sharp edges are rounded on a Sub-O-Matic 8-station, submerged type barrel finishing machine made by the Almco Division of Queen Stove Works, Inc. All operations on this machine are completely automatic, with the exception of mounting and removing the barrel covers, which must be done manually.

A controlled quantity of abrasive chips (about 400 lb.) falls on to a belt conveyor from an overhead storage hopper, and about 400 gears per barrel drop on to the chips from the loading chute, as seen at the centre in Fig. 7. The hopper holds about 800 lb. of chips, which are re-circulated. Rotary screens with holes of various sizes are provided for sorting the chips, and those too small to be used further are rejected.

Fig. 9. A "Memory Circuit" Machine for Inspecting Completed Gears and Segregating them into Six Classifications, According to Width

From the conveyor, the gears and chips fall into one of the barrels, and the lid is clamped in place. The barrels are alternately elevated and lowered by a hydraulically-controlled centre frame, and transferred to successive tanks by an overhead walking beam conveyor. Solutions in the various tanks provide for cleaning, rinsing, deburring, and rust-inhibiting treatments. At the unloading station, the parts and chips drop on to another conveyor belt. A permanent magnetic drum and cleated belt are used to separate the gears from the abrasive. In addition, a Lamb sorting unit is provided to separate the two types of gears, orientate them, and feed them, in a rolling position, back to their respective lines.

Deburred gears are elevated to the Lamb parts washer and 2,000-piece storage unit shown in Fig. 8. From the bottom of the spiral storage unit, the gears roll down a chute to another elevator (seen at the left) and are fed to a Sheffield gauging and classifying machine (Fig. 9). In this machine, the gears are segregated into six width classifications for matched assembly with the driving pump gears. The classifications are oversize (more than 0·3765 in. wide); Class A, 0·3760 to 0·3765 in. wide; Class B, 0·3755 to 0·3760 in. wide; Class C, 0·3750 to 0·3755 in. wide; Class D, 0·3745 to 0·3750 in. wide; and undersize (less than 0·3745 in. wide). A Lectrolair memory circuit is employed to open the gate to the appropriate chute after gauging, and the gears are stacked as shown. Final inspection of accepted gears is completed with hand gauges.

Fluoroscopic Examination of Aluminium and Magnesium Castings

The Quality Control Department of Chance Vought Aircraft, Inc., U.S.A., has recently investigated the possibilities of saving time and cost by fluoroscopic examination of aluminium and magnesium castings. For this purpose, a high-intensity fluoroscope, developed by the U.S. Naval Ordnance Laboratory, was loaned to the company. Some 2,000 light alloy castings were examined and it was concluded that if parts for exacting applications were inspected in this way, it would only be necessary to carry out X-ray examination on a percentage basis. For less critical parts, it is thought that X-ray inspection can be eliminated. Two X-ray tubes were used in the fluoroscope during the tests, namely a 900 KVP-MA, and a special high power 4,000 KVP-MA tube.

For examination, a casting is placed in a plastics bubble where it is held in position with toy rubber ballons as seen in the figure. The bubble can be turned to enable the casting to be inspected from any direction. It was found that the cost of fluoroscopic inspection of four typical castings ranged from 14 to 18 cents, whereas for X-ray examination, the costs varied from 0·8 to 1·96 dollars.

Light Alloy Castings for Fluoroscopic Examination are Held in Place in a Plastics Bubble by Means of Toy Rubber Balloons

When the high-power tube was used, micro-shrinkage and gas porosity could be detected in sections up to ½ in. thick, but grading was difficult. A beryllium window has now been acquired and further tests in connection with micro-shrinkage defects will be carried out.

IMPORTANCE OF SYSTEMATIC DRILL SHARPENING. Tests carried out in the laboratories of the National Twist Drill & Tool Co., U.S.A., and reported in their journal, *Metal Cuttings*, showed that important economies could be obtained by timely re-sharpening. Holes of $\frac{3}{16}$ in. diameter were drilled through a 2-in. thick test block of chromium-nickel alloy steel, and it was found, for example, that, after 50 holes, a drill could be reconditioned by the removal of 0·04 in. When this drill was kept in operation for a further 20 holes, the wear which then took place necessitated the removal of nearly 0·25 in.

Interferometer for Checking the Parallelism of Slip Gauges

To enable the parallelism of the working faces of slip gauges to be checked more conveniently and accurately than by previous methods, a new interferometer, as shown in Fig. 1, has been designed by Mr. J. B. Saunders, of the U.S. National Bureau of Standards. This instrument was developed as part of the programme for improving the accuracy of dimensional standards available to industry.

In Fig. 2, the arrangement of the principal components of the instrument is indicated, and Fig. 3 is a simplified optical diagram. Referring to Fig. 2, light from a point source at *A* is passed through a collimating lens *B*, and the resulting parallel beam is directed normal to one surface of the double image Kösters prism *C*. The latter comprises two 30-60-90 deg. prisms cemented together. A semi-transparent aluminium layer is deposited on the mating face of one of the prisms before they are assembled. Part of the light which enters the composite prism passes through the aluminized layer, and is reflected directly downwards by the opposite face, and part is reflected by the layer to the entry face and thence directly downwards.

The slip gauge to be checked is supported at the point *D*, on one side of the transverse plane indicated at *E*, and light falling on its surface is reflected back to the composite prism, whence it passes to the objective lens *F* and the micrometer eyepiece at *G*. Light on the other side of the transverse plane enters the right-angle prism *H* and after reflection from two faces, passes upwards to the under-surface of the slip gauge. Thence, it is reflected back to the right-angle prism and so returns to the composite prism which directs it to the objective lens *F* and micrometer eyepiece *G*.

Only the upper surface of the slip gauge is indicated in Fig. 3. Here a ray of collimated light *a*, after entering the composite prism, is divided at the point *b* into two components. After internal reflection, the two rays emerge along symmetrical paths *c* and *c'*. If the reflecting surface *d d'* of the slip gauge is at right angles to these rays, they are reflected back along the same paths to the point *b*, where half of one ray combines with half of the other to form the ray *e*. Since both rays have traversed equal optical paths, no interference fringes are formed. If, however, the surface *d d'* is assumed to be turned through a small angle θ to the position *f f'*, the rays will return along the paths *g* and *g'* and will emerge in the directions *h* and *h'*. The lengths of the two paths now differ, and if this difference is an even number of half-wave lengths of the light employed, the rays will reinforce one another when they are brought together by the lenses in the viewing tube, whereas if the difference is an odd number of half-wave lengths the rays cancel one another and a dark band is observed. The amount of the difference depends on the distance of the symmetrical rays from the line through the centre *k*

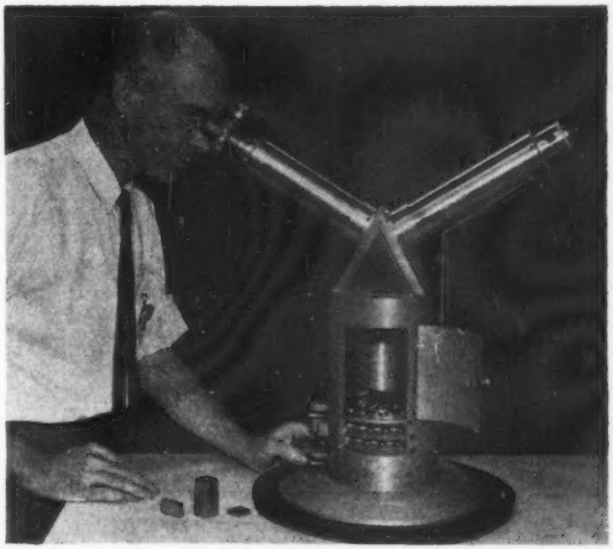


Fig. 1. Interferometer Developed by the U.S. National Bureau of Standards for Checking Parallelism of Slip Gauge Faces

of the reflecting surface and at right angles to the plane of the diagram. Consequently, the fringes lie in a direction at right angles to the plane of the diagram, that is say, parallel to the central plane *K* in Fig. 2.

It will be appreciated that, if the gauge surface were tilted about the axis *d k d'*, no fringes would be produced since the changes in path length would apply equally to both rays of a symmetrical pair. The instrument will thus measure one component of inclination at a time, and to measure the other component the gauge block is turned through 90 deg. in the horizontal plane in Fig. 2.

Rays from the composite prism which are projected downwards on the other side of the transverse plane to the right-angle prism and are reflected back from the under-surface of the gauge, will similarly form interference bands if this surface is inclined, and these bands will also be observed in the eyepiece.

In operation, the right-angle prism is first adjusted so that the plane of its upper surface is at right angles to the rays from the composite prism. When this adjustment has been correctly

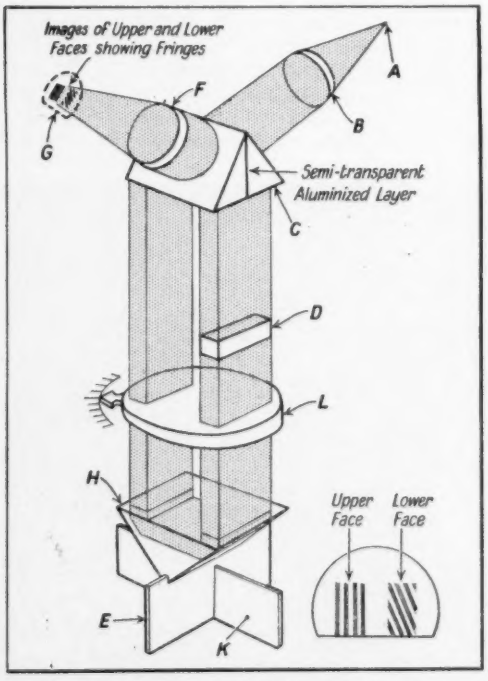


Fig. 2. Diagram Showing the Principal Components of the Interferometer

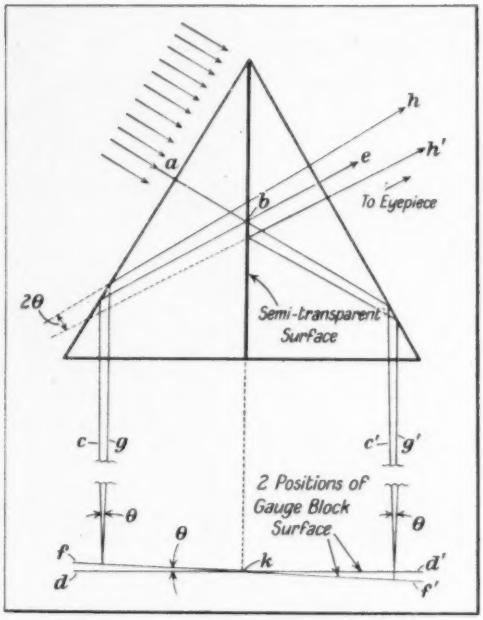


Fig. 3. A Simplified Optical Diagram Concerned Only with the Upper Surface of the Slip Gauge

made, no interference fringes are visible in the background of the field. The inspector is seen making this adjustment in Fig. 1. Next, with the gauge block in position, the perforated plate on which it is supported is adjusted to bring the upper surface at right angles to the light rays, a second knurled disc being provided for this purpose. This condition is indicated by the disappearance of fringes from the portion of the field corresponding to the upper surface of the work. Any lack of parallelism between the upper and lower surfaces will then be revealed by fringes in the portion of the field corresponding to the lower surface. If 2·6 fringes are observed, for example, the inclination of the surface is $2{\cdot}6\lambda/2L$ radians, where λ is the wavelength of the light employed and 2L is the length of the block, measured at right angles to the central plane *K* in Fig. 2.

To enable the mutual inclination of the two gauge surfaces to be read directly, two modifications have been made to the basic instrument thus far described. One of these modifications is concerned with the compound prism. While the cement between the two portions is still soft, the two components are twisted in relation to one

another through an angle of a few seconds of arc. As a result, the two beams emerging from the base on either side of the central plane are no longer exactly symmetrical, although each is still parallel to the central plane. When the upper face of the slip gauge is then set at right angles to the light rays, a permanent set of fringes at right angles to the central plane in Fig. 2 appears. If the lower surface of the gauge is parallel to the upper surface, a corresponding set of fringes parallel to those of the upper surface will be observed. On the other hand, if the gauge surface has a component of inclination about a horizontal axis in the central plane, the fringes will be turned through an angle that depends on the magnitude of this component.

The second modification involves the introduction of a circular glass wedge which is located between the gauge and the right-angle prism, as seen at *L* in Fig. 2. This wedge can be turned about a vertical axis and enables a controllable amount of difference to be introduced in the optical paths of the two rays of a symmetrical pair. When the two planes of the wedge are at right angles to the central plane, the two paths are changed by equal amounts and the fringe pattern is unaffected. In other positions of the wedge, the two paths are affected differently and by suitable adjustment it is possible to compensate for the inclination of the lower surface of the gauge. When this adjustment has been made, the two fringe patterns are parallel. A scale for the angular position of the wedge is so calibrated that a direct reading of inclination is obtained.

Monochromatic light is employed when calibrating the instrument, but white light may subsequently be used without materially affecting precision, since it operates on the null principle.

Automatic Position Indicator for Use with Dynamic Balancing Machines

By V. SEALE-FINCH*

In automatic balancing machines, the work is rotated about its axis or spindle, and the forces resulting from unbalance operate transducers. The output of these transducers is amplified and gives information as to the amount and angular position of the unbalance.

A conventional method of indicating the position is to mark the workpiece in some distinctive way, for example by sticking a strip of numbered tape around it, and illuminating this marking by a stroboscopic lamp which is triggered once per revolution by the output of the transducer amplifier. This method fails in three cases. When the workpiece is very heavy and the rotational speed is low, the light output of the stroboscopic lamp is insufficient to give a clear indication of the position of unbalance. If the workpiece is very light, then the mere fact of adding something, such as a numbered tape, can contribute an unbalance which is greater than that inherent in the workpiece. If the machine is used for quantity production, the time consumed in applying the marking device is an objection.

Various alternative methods have been used.

* E.M.I. Electronics, Ltd.

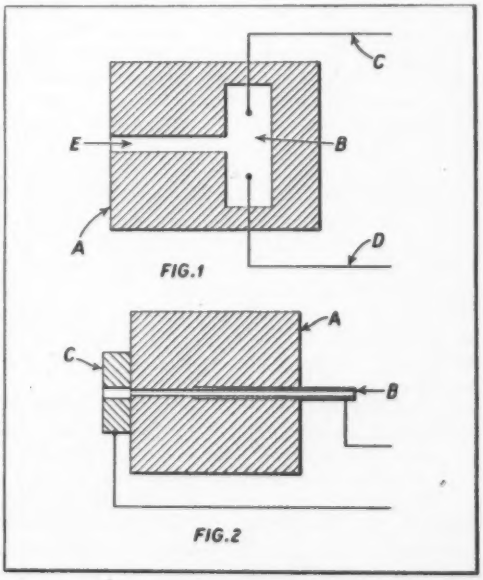


Fig. 1. A Spark Discharge in a Cavity Results in Expansion of Air

Fig. 2. When the Discharge Takes Place within a Liquid a Small Quantity is Expelled

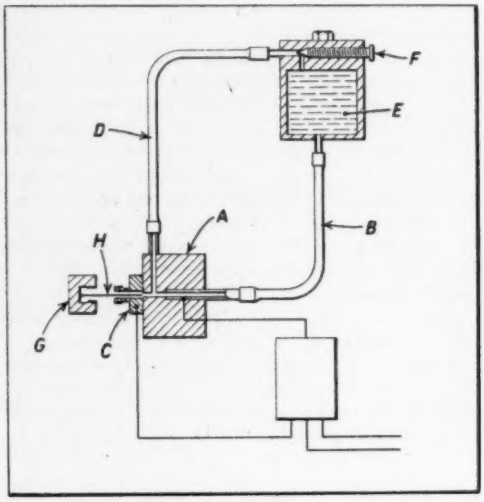


Fig. 3. Diagram Showing the Arrangement Adopted to Ensure a Continuous Supply of Liquid

With large workpieces it is possible and practicable to instal a generator, which is driven in phase with the work, to measure the phase difference between its output and the output of the transducer amplifiers, and to display this phase difference on a meter which will directly indicate the angle between the centre of gravity and some datum. Another method, which has been applied, for instance, to the balancing of small items such as gyroscope wheels, is to use the peak of the unbalance signal, not to trigger a stroboscope but to pass a spark which causes a microscopic pit to be eroded on the surface of the gyroscope wheel. The surface is so highly finished that microscopic pits are readily visible.

This spark marking method is attractive because it does not require any preparation to be carried out on the work, such as applying a numbered tape or coupling up a generator. It is unsuitable, however, for many industrial applications where the finish of the workpiece is such that the pitting caused by the spark discharge would pass unnoticed.

An alternative method, which combines the operational advantages of the spark method with an easily visible mark, has been developed. In Fig. 1 is shown a block of insulating material *A* in which there is a cavity *B* enclosing two electrodes *C* and *D*. A high voltage pulse, similar to that which conventionally triggers the stroboscope tube, causes a discharge between *C* and *D*, and, as a result, a quantity of air is expelled through the aperture *E*. If a small amount of liquid is present in this exhaust passage, it will be expelled with a high velocity.

During the course of development, it was found that the discharge could take place within a liquid, and that the gas thereby generated would expel a small quantity of the liquid. The apparatus then takes the form indicated in Fig. 2, where *B* is a metal tube, containing ink which passes through the insulating block *A* and into the metal orifice *C*.

If the equipment is to be used for quantity balancing, it is necessary to replenish the liquid reservoir and the system shown in Fig. 3 has proved successful. This arrangement is, in fact, no more than a conventional automatic drinking fountain as used on poultry farms, but with a fine control of the maximum rate of flow. So long as there is ink in that part of the tube which lies to the left of the pipe *D*, no air can enter the reservoir *E*, and the ink is retained. A fine ink feed control *F* is provided.

Care must be taken when setting up initially to achieve a compromise between various factors affecting performance. These factors are the dimensions of the supply tube, the viscosity of the liquid, the dimensions of the exhaust orifice, and the repetition rate of the impulses. Once a suitable combination has been determined at the design stage, there is no need for subsequent changes, and the apparatus is quite automatic. It may sometimes be necessary to provide a cap *G* to cover the exhaust orifice when the machine is not in use, particularly if the paint employed tends to clog as a result of evaporation. A wire needle *H* may also be provided.

Although the liquid emerges at a very high velocity, it is desirable that the exhaust orifice should be as close to the work as is convenient. In practice, a separation up to ⅜ in. is permissible, and under these conditions rapid loading and unloading of the work presents no problems.

COOLING EFFECTS OF TELLURIUM SEMICONDUCTORS.—In connection with research at the Battelle Institute, U.S.A., it has been found that an interesting cooling effect is exhibited when an electric current is passed through a specially prepared sample of bismuth telluride. Theoretically, it is pointed out, the cooling capacity of a number of bismuth telluride elements used together is sufficient to liquify air directly, without resorting to compression. It is considered that this cooling effect could be applied to refrigeration, and that its significance is not yet fully realized.

Drilling Small Holes by the Ultrasonic Method

By N. K. MARSHALL

At the works of the Telecommunications Department of Lockheed Aircraft Corporation, Missile Systems Division, California, U.S.A., it was required to drill a batch of ferrite cores of the form shown in Fig. 1. The brittle, vitrified iron-oxide material has machining characteristics similar to those of glass, and it was specified that four 0·015-in. diameter holes through each core should be accurately spaced, clean, straight, and parallel with the core axis. Various methods were tried without success, before the problem was eventually solved by the use of a small ultrasonic head of the type seen in Fig. 2.

For the construction of the first experimental head, Permendur laminations were employed because they happened to be available. These laminations had originally been stamped for use in a magnetostriction hydrophone, but any other suitable magnetostrictive core material could have been employed. An exponential-cone type extension was carefully machined from brass, to dimensions determined on the basis of the velocity of sound propagation in this material, and an accurately-centred hole was provided for the drill. This cone was secured to the lamination stack with Araldite resin. The head shown in the centre in Fig. 2 incorporates a barium titanate transducer.

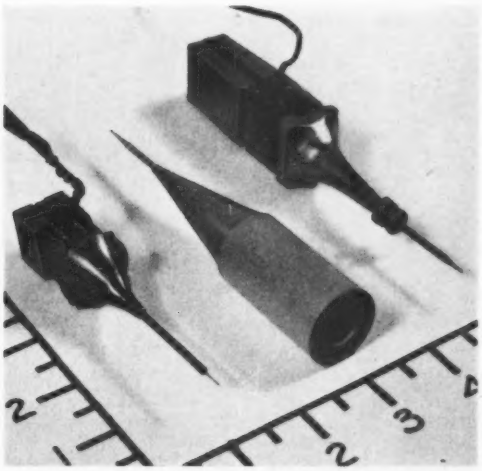


Fig. 2. Magnetostruction and Barium Titanite Heads for Drilling Small Holes

A brass wire of 0·013-in. diameter by 1¾ in. long is employed for the drilling operation, and is a loose fit in a 0·020-in. hole in the exponential cone, so that it can rotate freely in operation.

The head is used in conjunction with a type 211A Hewlett-Packard generator and a McIntosh type Mc30 power amplifier. A close-up view of the experimental set-up is given in Fig. 3, the head being suspended from an adjustable bracket by means of a resilient support, so that almost the whole weight is carried on the drill point. Cores to be drilled are cemented to a piece of plate glass, which is placed on top of a mirror so that it is possible to observe when the drill breaks through.

In operation, the drill is accurately positioned and the frequency

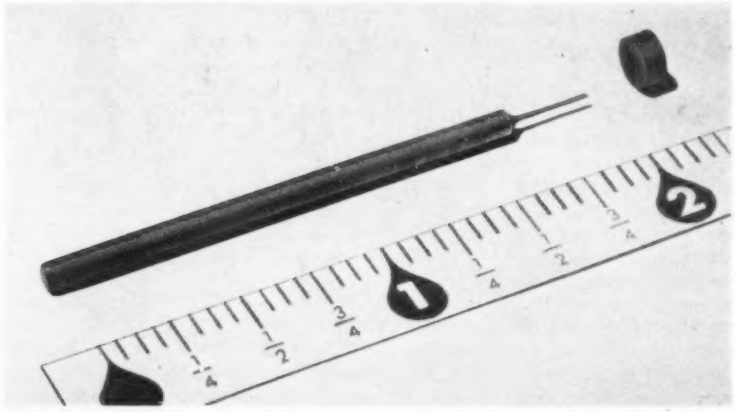


Fig. 1. Tool Employed for Drilling Ferrite Core by the Ultrasonic Method

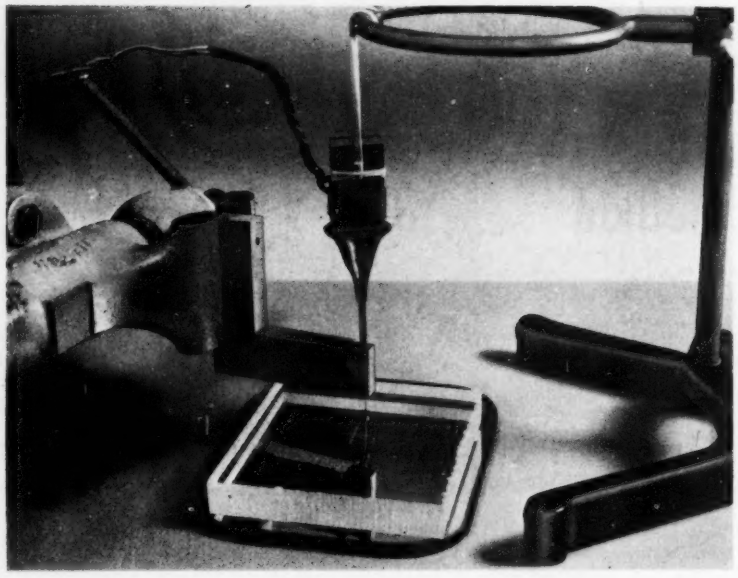


Fig. 3. Experimental Set-up for Drilling a Ferrite Core Cemented to a Piece of Plate Glass

varied until a fine dust appears at the point where the drill touches the work, after which the frequency is set for maximum cutting action. For starting, a diamond impregnated wire is used dry to facilitate accurate location. As soon as there is a noticeable dent in the work surface, a small amount of diamond paste is applied with a toothpick, and suffices for about 4 min. drilling, after which the supply is renewed. When the hole has been started, the waveform generator is adjusted so that a rotary motion of the drill is obtained. At the same time, it is subjected to a vertical vibration frequency of 24 kilocycles. Under these conditions, a 0·090-in. deep hole is drilled in an average time of 6 min. to a diameter of 0·015 in. ±0·0015 in. A drill, which is inexpensive to make, will produce about 10 holes before it must be discarded.

The method described has proved satisfactory for small quantities, and, if it was required to process cores in large numbers, arrangements could be made for drilling the holes simultaneously and automatically.

It may be noted that holes as small as 0·005 in. diameter have been drilled successfully in hard materials by this method, also that an ultrasonic drill, with a high-speed air-driven rotary motion, is being used experimentally on industrial diamonds.

Ferrite cores drilled in the manner here described are subsequently wound by hand with No. 48 copper wire.

Rezalloy "Liquid Steel" Compound

A "liquid steel" compound known as Rezalloy, has recently been placed on the market by Terov, Ltd., Central House, Fratton Bridge, Portsmouth.

Containing 80 per cent steel and 20 per cent plastics material, the compound is suitable for the production of jigs, tools, fixtures, moulds, and forming and stamping dies for metal parts. It can also be used for filling holes in castings, and for bonding metals to each other and to ceramics and plastics. The material is prepared for use by mixing with a hardening agent, and the mixture may then be poured into a mould. To prevent adhesion, all metal surfaces which are brought into contact with the mixture during pouring, should be coated with grease, preferably of the silicone type. When adhesion of the mixture is required, metal workpieces should be thoroughly cleaned in a solvent such as trichlorethylene, and an improved bond is obtained if the surfaces are roughened.

Hardening of the compound takes place at room temperature (about 60 deg. F.), in a period of approximately 2½ hours. In the hardened condition, the compound forms a strong, tough, rigid metallic mass, which may be filed, sawn, threaded and ground. It has a high impact strength, and good resistance to abrasion and the action of most solvents, acids and alkalis.

Weighing 2 oz. per cu. in., the compound has a tensile strength of 15,000 lb. per sq. in., a compressive strength of 18,000 lb. per sq. in., and a shrinkage factor of 0·0005 in. per inch. The compound and hardening agent are supplied in separate containers of two sizes, which will produce quantities of mixture weighing 1·1 and 2·2 lb.

New Production Equipment

Swift Duplex Copy-turning Lathe for Turbine Discs

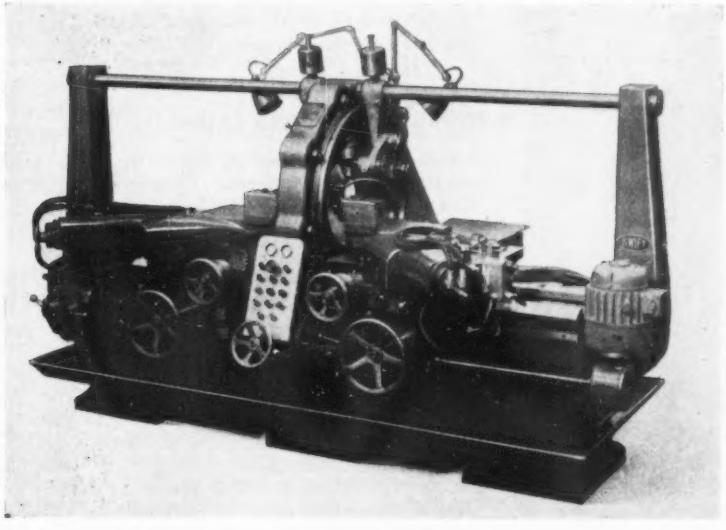
George Swift & Sons, Ltd., Claremont Works, Halifax, have recently built the duplex copy-turning lathe, here illustrated, for machining simultaneously the two sides of thin-walled components, such as turbine discs, up to 24 in. diameter. It has a central driving headstock with a large inner sleeve, which is machined to receive fixtures on which the components are mounted. The sleeve runs in roller bearings and is driven either by V-belts, or preferably by a timing belt, from a 7½-h.p. motor at the rear of the machine.

Right- and left-hand saddles are mounted on the vee and flat shears of the 12 ft. long bed, and each carries hydraulic copying slides. On each flat-topped saddle there is a base slide, which is arranged to swivel in order to reduce the displacement of the stylus for a given work form, and the copying slide, which is carried on the base slide, can also be swivelled to compensate, if necessary, for the angular setting of the base slide. Incorporated in the base slide is the automatic cross-feed mechanism, the drive for which is transmitted upwards through the swivel point. The motion of the two saddles is synchronized both for feed and rapid power traverse, so that it is impossible for them to get out of step, and any necessary hand adjustment is obtained from the central handwheel.

The feed gearbox, mounted at the left-hand end of the bed, is driven by a 1-h.p. motor, and provides nine rates of surfacing feed. Rapid power traverse for the slides is transmitted through the feed-shaft from a 1-h.p. motor and worm reduction gearbox at the right-hand end of the lathe. A magnetic clutch serves as an interlock to ensure that the feed and rapid power traverse motions are not engaged simultaneously.

A 4-way toolpost with magazine-type toolholders is mounted on each copying slide. Provision is made in the main drive for varying the r.p.m. of the work to provide a constant cutting speed. To steady the central driving head, overarm supports are fitted, and they carry brackets for damping members which reduce vibration of the work. The right-hand damping member also incorporates a loading arrangement for the work.

The machine is arranged so that coolant can be used, if required, and the approximate weight is 6 tons.



Swift Duplex Copy-Turning Lathe for Turbine Discs

Renold Sprag Clutches

In the illustration is shown a cut-away view of a sprag clutch from the range which Renold Chains, Ltd., Wythenshawe, Manchester, have recently started to make under licence from the Formsprag Co., Detroit, Michigan, U.S.A.

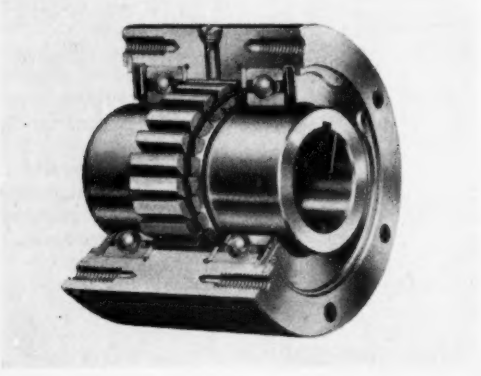
Drive is transmitted by the wedging action of a number of closely-spaced steel sprags which occupy an annular space between the inner and outer members of the clutch. When one of the clutch members is turned in one direction, these sprags are tilted by the action of circular coil springs housed in slots at their ends, by which they are held lightly in contact with the mating surfaces so that there is no lost motion when the drive is taken up. The shape of the sprags is such that when the driving member is stopped or reversed, the contact portions are swung clear of the mating surfaces so that the drive is disengaged.

The clutch can thus be employed to provide a free-wheel action. Alternatively, one member may be fixed, and a continuous or an intermittent non-reversing drive, with a positive back-stop action, can then be transmitted by the other member. If required, a crank disc and connecting rod may be coupled to the inner member to provide an indexing motion which is similar to that obtained by a ratchet and pawl mechanism, but can be varied steplessly.

The clutches are made in more than 70 standard sizes, the smallest of which have bores of ¼, ⅜ and ½ in. diameter, and are intended for light-duty applications in office machinery, domestic appliances, and precision mechanisms, for example. Suitable for operation at speeds up to 2,400 r.p.m., these clutches will transmit up to 50 and 200 lb.-in. torque, and the inner members run in plain bearings. Clutches intended for medium-speed, light-load duties and fitted with plain bearings are made with bores from ⅜ to 2 in. diameter. They will transmit from 10 to 1,310 lb.-ft. torque, and the inner members can be driven independently of the outer members at maximum speeds ranging from 1,800 to 700 r.p.m.

The clutch shown in the figure incorporates sealed ball bearings, and is available with maximum bore diameters from ¾ to 3¼ in. From 95 to 1,900 lb.-ft. torque can be transmitted according to the size of the clutch and the inner member may be driven separately at speeds ranging from 2,400 to 1,800 r.p.m. The external diameter of the outer members range from 3½ to 7⅛ in., and the overall lengths of the inner members from 2¾ to 5 in.

The range also includes series A sprag clutches, which are specially designed to permit high-speed over-running of the outer members, and are particularly intended for use in dual drive systems. They are available with bores ranging from 2 to 5½ in. diameter, and will transmit from 1,875 to 11,600 lb.-ft. torque. The outer member runs on ball bearings, and may be driven at maximum speeds ranging from 3,000 to 1,000 r.p.m. Made in similar sizes and capacities, the series B and C clutches are primarily intended for non-reversing drives and indexing duties, and the inner members may be driven independently at maximum speeds of 900 to 600 r.p.m. The largest clutches in the range have bores of 6 to 12 in. diameter, and will transmit from 18,500 to 136,000 lb.-ft. torque at maximum speeds ranging from 185 to 100 r.p.m. The latter clutches are primarily intended for use as hold-backs for heavy-duty conveyors.



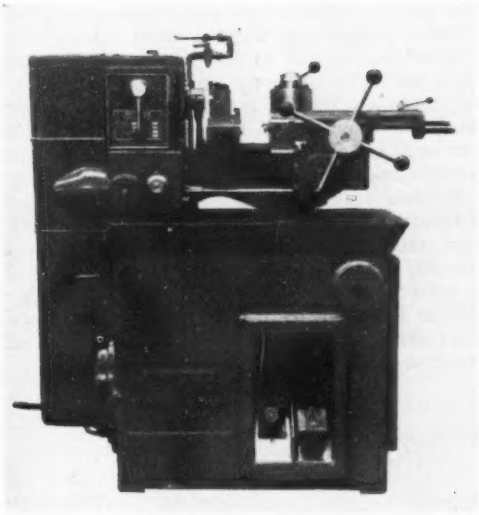
Cut Away View of a Sprag Clutch from the Range Made by Renold Chains, Ltd.

Murad ½-in. Capstan Lathes

A range of ½-in. capstan lathes has been introduced recently by Murad Developments, Ltd., Stocklake, Aylesbury, Bucks, and are known as the OA, OB and OC, the latter being shown in the illustration.

Each machine has six spindle speeds, in the forward and reverse directions, ranging from 355 to 4,000 r.p.m., and the spindle, which carries a dead length collet, is driven through V-belts by a two-speed ½/2-h.p. motor. All slides are hand-scraped, and adjustable dead stops are provided. The OA machine has a lever-operated collet mechanism, and hand feed for the turret slide, whereas the OB and OC machines have three power feeds, of 0·0025, 0·0045 and 0·010 in. per rev.

On all three machines the pneumatic bar feed is



Murad OC Type ½-in. Capacity Capstan Lathe

interlocked with the collet mechanism, so that the collet is opened, the bar is fed through, and the collet is then closed. This sequence is controlled by a hand lever on the OA and OB machines, and by a pedal on the OC type. On the latter, moreover, the collet is opened pneumatically, but is held closed mechanically, to ensure the workpiece is not released should the air supply fail.

These machines will admit 10 in. between the front face of the collet and the turret, and the maximum stroke of the turret slide is 4 in. A distance of 4¾ in. may be obtained between the cross-slide tool posts, and each has a transverse movement of 4¼ in. Automatic lubrication is provided for the feed gearbox by a built-in pump, and a self-priming coolant pump is fitted as part of the standard equipment of each machine.

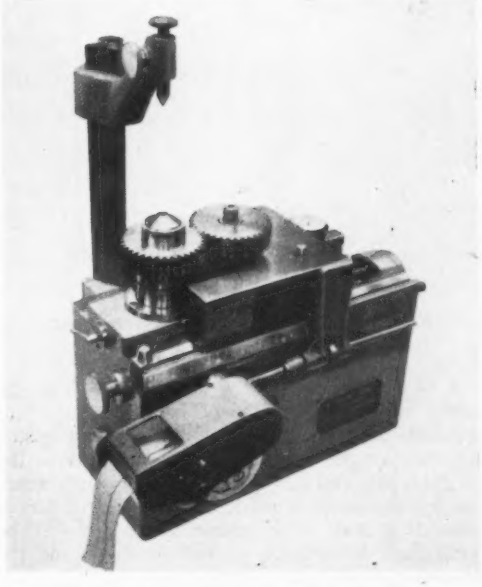
David Brown No. 9R Recording-type Roll Testing Machine for Gears

The accompanying figure shows the No. 9R roll testing machine which has been developed recently by the Tool Division of David Brown Industries, Ltd., Lockwood, Huddersfield. The machine, which has an overall length of 24 in., provides for checking the concentricity, tooth contact, centre distance and tooth thickness of a wide range of gears, and, in its standard form, will accommodate spur and helical gears which have centre-distances between 1⅞ and 9 in. Attachments are also available for checking shaft-, bevel and worm gears.

Gears under test are driven by a variable-speed motor, which also drives the paper reel, whereon a graph is automatically recorded. The dial indicator, on which errors are shown, is operated by a sensitive carriage, which is loaded by an adjustable spring pressure. The standard indicator is graduated in 0·0005-in. divisions, but 0·0001-in. graduations can be provided. Actual gear centre distances are read directly from the vernier scale at the front of the machine.

The recorder has an actual error capacity of 0·008 in., and as the magnification is 250 to 1, an error of 0·0002 in. is shown as 0·05 in. on the graph paper. The ratio of the drive is such that one revolution of the gear under test gives a graph with a length of 12 in. The variable-speed motor provides for gear speeds from ¾ to 2 r.p.m., and both the gear and graph paper movements are positively driven. An ink reservoir, of ample capacity, feeds the recording pen, which can be used over considerable periods without attention.

The shaft-gear attachment incorporates a V-section pillar which carries an adjustable centre, as shown in the illustration. Units for bevel and worm gears can be mounted separately on the sensitive carriage.

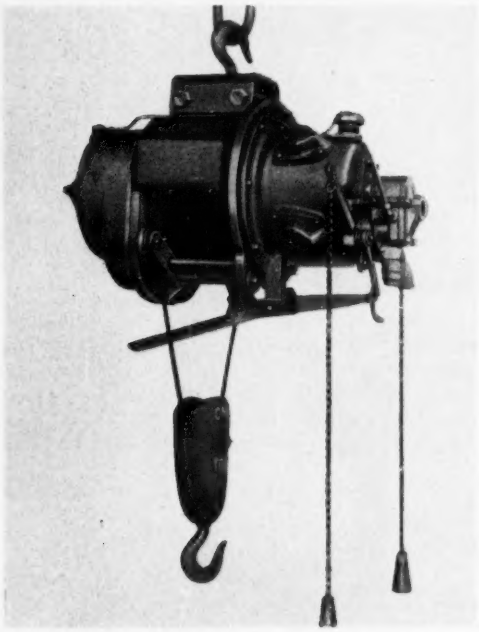


David Brown No. 9R Recording-type Roll Testing Machine for Gears

With this instrument, the backlash in a pair of gears can be calculated by noting the difference between the working centre distance and the centre distance when the gears are run together in metal-to-metal contact.

Ingersoll-Rand Size C Air-powered 1-ton Hoist

The size C air-powered hoist, shown in the illustration, is now being made, and marketed, in this country by the Ingersoll-Rand Co., Ltd., 165 Queen Victoria Street, London, E.C.4.



Ingersoll-Rand Size C Air-powered 1-ton Hoist

A 4-cylinder air motor is employed to drive the cable drum, the cylinders being arranged as opposed pairs in a cross-formation. Each piston has two rings, one above and one below the gudgeon pin, and is connected to a common crank pin by means of a solid, one-piece, drop-forged connecting rod, with renewable bushes. The crank-shaft is mounted on ball bearings, and the drive to the cable drum is provided by spur reduction gears housed in the oil-bath casing seen on the left in the figure.

Control of the air motor is by a chain and lever-operated poppet-type throttle valve. This valve is sensitive in operation and allows the speed of the drum to be steplessly varied. The opposed layout of the cylinders, and the fact that there are four power impulses per revolution, ensures smooth operation, and a graduated valve is fitted to ensure freedom from snatch on reversal.

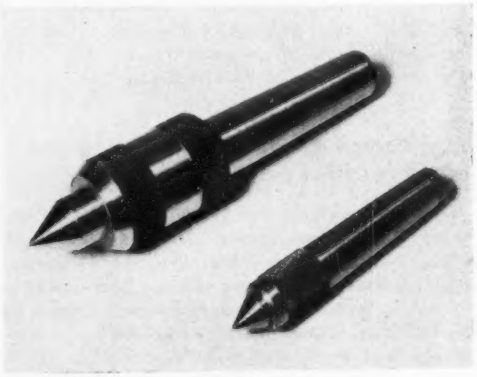
Anti-friction bearings are provided for the top and bottom hooks, and the hoist has automatic stops and a brake. The hoist illustrated has a capacity of 1 ton, a lift of 15 ft., and weighs 355 lb. inclusive of the top hook. A 4-wheeled trolley, suitable for use with an I-beam, can be supplied as an alternative to the top hook, and the overall weight is then increased by 35 lb.

Volumax Rotating Centres

In the illustration are shown two sizes of Volumax rotating centres which have recently been introduced by the Sigmax Engineering Co., Coronation Road, High Wycombe, Bucks.

The type 103H centre seen on the left has a No. 3 Morse taper shank, and the diameter of the body is 1⅝ in. The cone centre runs in a needle roller bearing at the nose end and a phosphor bronze bearing at the rear. Axial load is taken by a thrust race, through a neoprene ring, which obviates the risk of seizure if heavy loads are applied to the centre due to expansion of the workpiece.

On the right is shown the type 102L centre, which has a No. 2 Morse taper shank, and a ¾-in. diameter body. The cone centre runs in needle roller bearings, and end thrust is taken by a ball bearing and a neoprene ring.

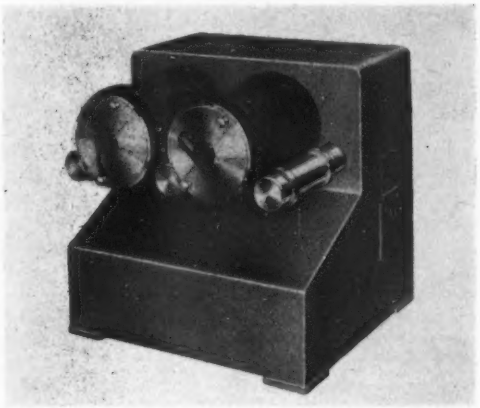


Volumax Rotating Centres

Volumax rotating centres are sold by A. Douglas & Co., Ltd., Lancaster Road, High Wycombe, Bucks.

Redgrave Dean Barrel Finishing Machine

A new dual-container barrel finishing machine, as shown in the accompanying figure, has recently been introduced by Redgrave Dean & Co., Ltd., Station Road, Coleshill, Warwickshire. Occupying a floor space of 30 in. by 24 in., and having a height of 27 in., this machine has a body of welded steel which encloses a ½-h.p. motor coupled to an Opperman oil-filled reduction gearbox. The final drive is taken through V-belts and pulleys to 3 electro-plated rollers mounted on the front of the



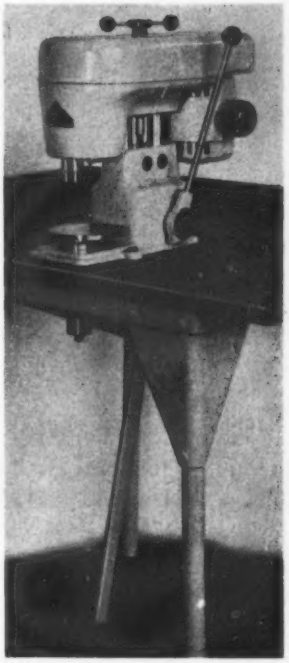
Redgrave Dean Barrel Finishing Machine

machine. Barrels of moulded rubber, reinforced with steel, may be rotated on the supporting rollers at speeds of 45 or 75 r.p.m. Ribs are moulded inside the barrels in order to promote greater agitation of the contents. Each barrel has internal dimensions of 8¾ in. diameter by 13 in. long and a capacity of 2·6 gallons. A water-tight seal is fitted between the lid and body. This machine is now available in addition to the larger 8-barrel type.

Hufel Type MB-2n 2-spindle Spin Riveting Machine

Shown in the accompanying illustration is the German-built Hufel type MB-2n, 2-spindle, spin riveting machine marketed by Broadway Equipment, Ltd., 194-196 Finchley Road, London, N.W.3. The machine has capacity for closing hollow rivets up to ¼ in. diameter, and the centre distance of the spindles is adjustable from ¾ to 2¾ in. There is a separate torque control for each spindle, and rivets at different heights up to ⅜ in. can be handled simultaneously. A single-spindle unit is available, and the manufacturers are able to undertake the construction of special-purpose riveting machines of a similar type.

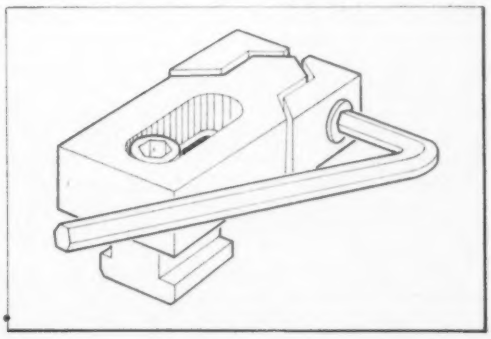
Hufel Type MB-2n, 2-spindle Spin Riveting Machine



Rubert Edge Clamp

The edge clamp shown in the accompanying line drawing has recently been placed on the market by Rubert & Co., Ltd., Chapel Street, Levenshulme, Manchester, 19.

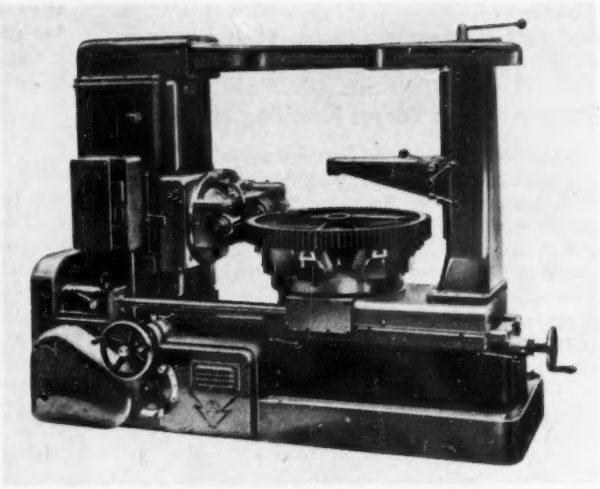
In use, clamping pieces at the nose end are



Perspective View of the Rubert Edge Clamp

brought into contact with one edge of the work, and the unit is then fastened to the table of a machine for instance, by means of a T-nut and a socket screw which passes through a stepped slot in the body. Movement of the clamping pieces towards the work is then effected by rotation of a separate socket screw with the aid of a key, as shown. As a result, both horizontal and downward clamping pressure is applied to the workpiece owing to the action between a cam and an inclined slot.

With this arrangement a high clamping pressure can be exerted. Alternatively, the work may be lightly held so that the risk of distortion is reduced. If required, two T-nuts can be provided for securing the clamp to a table when very high end thrust is to be applied. The clamp is made in three sizes with lengths of 3⅛, 3⅞, and 5½ in., widths of 1½, 2, and 2¾ in., and thicknesses of 7/16, ⅝, and ¾ in., respectively.



Almhults Type KF-2 Automatic Gear Hobber

Almhults Type KF-2 Automatic Gear Hobber

The type KF-2 automatic gear hobber shown in the figure has been introduced by the Swedish firm of Almhults, for whom the sole agents in this country are Mortimer Engineering Co., 204-206 Acton Lane, Harlesden, London, N.W.10.

This machine has a capacity for cutting spur and helical gears up to 47 in. diameter, and, if required, a tangential feed motion may be provided for the hob slide so that worm wheels can be produced with fly cutters. Gears with a maximum of 3 D.P. in steel, and 2½ D.P. in cast-iron can be cut at one pass. The hob saddle has a maximum travel of 23⅝ in. on the column ways, and 10 feed rates ranging from 0·0177 to 0·197 in. per table rev. are obtainable. Of 33⅜ in. diameter, the table has a central 4¼-in. diameter bore, and is traversed on the bedways by a 1⅜-in. diameter screw, the 10 feeds available ranging from 0·01 to 0·115 in. per rev. A minimum centre distance of 5 7/16 in. is obtainable between the work table and the hob spindle.

Drive to the hob spindle, work table and feed motions is taken from a 7½-h.p. motor. Rapid power traverse vertically at the rate of 27½ in per min. for the hob saddle, and horizontally at 16 in. per min. for the table, is provided by a separate 2-h.p. motor. The machine weighs approximately 9 tons and occupies a floor space of 10 ft. 3 in. by 5 ft. 3 in.

A smaller machine, designated type KF-1 is available, which has a capacity for cutting gears up to 23½ in. diameter with a maximum (for cast-iron) of 4½ D.P. The 19⅝-in. diameter work table has a 2⅜-in. diameter bore, and the maximum vertical travel of the hob saddle is 17 5/16 in. On this machine, the table can be driven at a speed of 16 r.p.m. by the rapid traverse motor.

Natco Type H-6 Multiple-spindle Drilling and Tapping Machine

The type H-6 multiple-spindle drilling and tapping machine, made by the National Automatic Tool Co., Inc., Richmond, Indiana, U.S.A., can be supplied with a longitudinally-indexing work slide which may be arranged to move through 2, 3, 4 or 5 stations. Associated control equipment is provided, and the working cycle can be pre-set, by means of dials, so that successive operations, such as drilling, tapping, and counterboring, are performed automatically. A machine fitted with this equipment is shown in Fig. 1, and Fig. 2 is a close-up view of the unit arranged for 3-station working.

A work-holding fixture is loaded with the slide at the left-hand end of its travel, and when the starting button is pressed the slide is hydraulically indexed to the second station, at which the com-

ponent is drilled. At the third station, a tapping operation is performed, and the slide is then returned automatically to the starting position, for unloading. Feed is applied by upward movement of the work table towards the tools, initially under rapid power traverse and then at a pre-set rate, different rates for drilling and tapping being selected by separate dials.

During a drilling cycle, immediately the upward feed movement has been completed, rapid power traverse in the downward direction is engaged so that the work is brought clear of the drills. For chamfering, however, a dwell period is provided while the tool is in contact with the work, before the table is withdrawn. At the end of a tapping operation, the table is lowered at the appropriate rate until the part is clear of the taps, before the rapid traverse is engaged. The spindles are of the "floating" type, so that taps with different leads can be employed.

A maximum of 24 spindles can be provided, and they may be mounted on adjustable arms, or located at fixed centres by a plate on the head of the machine. Drive is transmitted through gears and universal joints from a 3- or 5-h.p. motor.

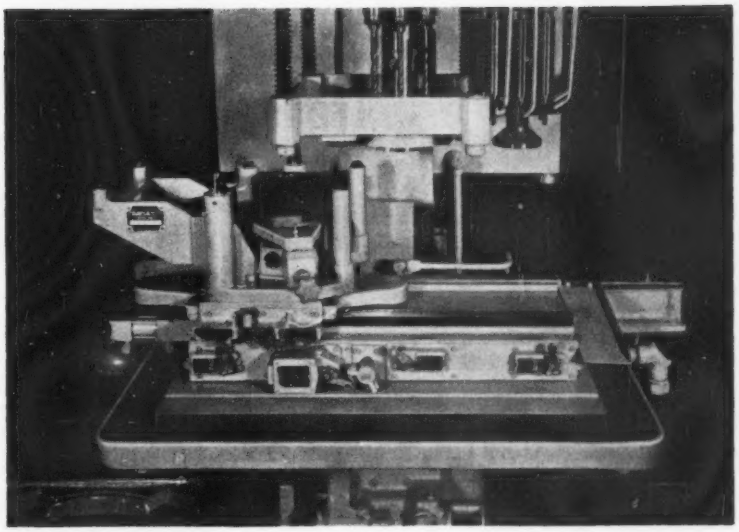


Fig. 2. Close-up View of the Indexing Work Slide Equipment Arranged for 3-station Operation

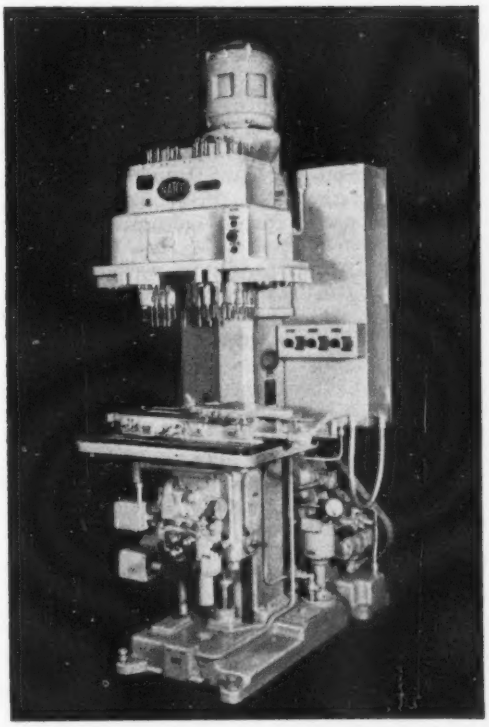


Fig. 1. Natco Type H-6 Multiple-spindle Drilling Machine with Indexing Work Slide

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PECTACRETE NON-DETERIORATING CEMENT has been developed in the laboratories of Pectacrete Cement, Ltd., and can be stored in atmospheres which have a high-humidity content, without solidifying. During manufacture, an additive is introduced which forms a film round each particle of cement. This film resists completely the action of water, and the cement can be stored under the most adverse conditions without the risk of deterioration. However, the mechanical abrasion which occurs when the cement is mixed breaks the protective film, and then the cement will solidify normally.

The Production of Chevrolet Turboglide Transmissions

Turboglide transmissions are being produced in large numbers, by highly efficient methods, at the Toledo factory of the Chevrolet Motor Division, General Motors Corporation, U.S.A.

Recently introduced, the Turboglide unit is a variable-pitch torque converter with three turbines and two simple planetary gear sets.

The factory comprises two buildings, one devoted to die casting and forging, and the other to press-work, machining, assembling and testing.

Aluminium die castings are used extensively, with the result that the weight of a car with a Turboglide unit is only 4 lb. more than that of the same car equipped with a standard 3-speed transmission. By comparison, it may be noted that the fitting of the optional Powerglide unit resulted in a weight increase of 92 lb. The heaviest and largest of these die castings is the main transmission case, which weighs approximately 14 lb. In Fig. 1 a case is seen after being ejected from the movable die member of the die casting machine. The horizontal cold-chamber Cast Master has a locking force of 1,200 tons, and is among the largest in use in the motor vehicle industry. The cycle is entirely automatic, and is started by a push-button which operates a sliding safety door in front of the dies. Once the door has been shut, the dies close, molten aluminium is injected, the dies open, a casting is ejected, and the door slides back.

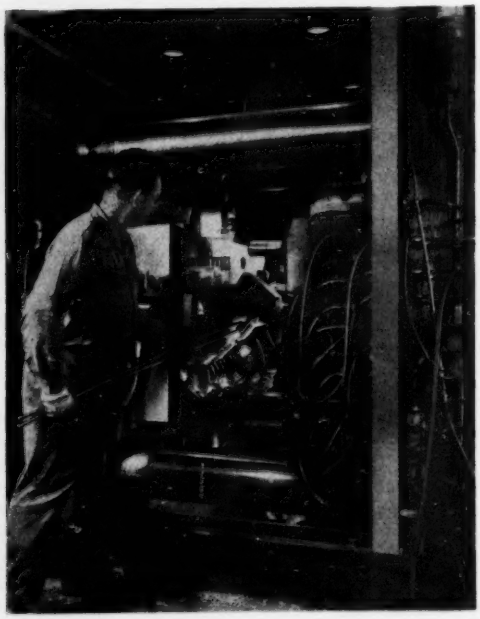

Fig. 1. The Largest Component of the Transmission is a 14-lb. Aluminium Casing Here being Removed from the Die Casting Machine

Dies for this part were supplied by the Atols Tool & Mold Corporation, Chicago. The movable member weighs 10¼ tons, and the stationary member, 9½ tons. Water continuously circulated through the dies keeps their temperature between 500 and 550 deg. F.

Since there is a number of machines engaged in die casting various aluminium parts, the casting area is provided with a central melting installation of three furnaces. One of these furnaces is reserved for virgin aluminium, and the other two are charged with both virgin and scrap metal. For the transmission case only virgin aluminium is used.

Ladles supported from a rail are employed to carry the molten metal to an Ajax holding unit at the side of each die casting machine. These units are induction-heated and maintain the metal at the required temperature. Other features of the aluminium foundry include a central pumping system which supplies the hydraulic fluid (water and soluble oil) for operating the die casting machines, and an underground conveyor system which carries the scrap from the trimming presses to the furnaces for remelting.

In the machining area, the transmission cases are processed on two duplicate transfer machines. Because of the form of the case configuration, pallets are used.

Before the cases reach the transfer machines, preliminary operations are carried out on the W. F. & John Barnes 5-station, indexing table machine in Fig. 2. One station is employed for loading and unloading, and at the remaining positions, four locating holes are drilled and reamed, and four locating pads are milled. In addition, an angular head at one of the work stations drills an oil-hole.

Each work fixture has a horn with three expand-

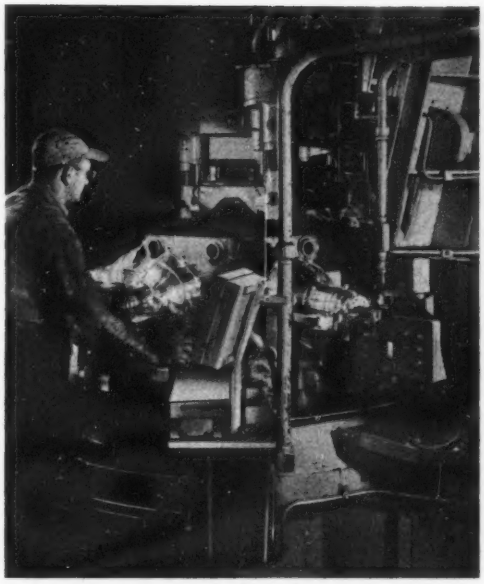

Fig. 2. Before the Transmission Cases are Passed to the Transfer Machines, Location Holes and Surfaces are Milled and Drilled at this Set-up

ing pins which engage the bore of the case, and to support the bell end of the housing, equalizing pins enter cored holes in the casting. Lugs at the front and rear are supported on jacks. Electrically - controlled pneumatic clamps are actuated automatically as each fixture is indexed away from, or to, the loading/unloading station. The machine operates on a continuous cycle, and one case is completed at each indexing movement. After being unloaded, the cases are suspended from either of two monorail conveyors, a separate conveyor being provided for each transfer machine.

Fig. 3. The Rectangular Layout of the Transfer Machine Enables the Two Ends and Two Sides of the Casing to be Presented to the Tool Heads at Different Stages of the Machining Cycles

RECTANGULAR TRANSFER MACHINES

These machines also were built by W. F. & John Barnes, and each has 45 stations. The majority are work stations, at which horizontal and vertical self-contained units perform a variety of operations, including milling, drilling, chamfering, and tapping. Other stations provide for loading/unloading, changing the direction of motion of the pallets, probing holes and pressure testing.

Each machine is in the form of a rectangle, and near one corner the work is loaded on to a pallet which is then advanced down one long side of the rectangle. When the pallet reaches the end of this side, a direction changing station causes it to pass along a short side of the rectangle. This procedure is repeated until the pallet returns to the starting point, and the completed case is then unloaded.

A close-up view of the loading/unloading station is given in Fig. 3. Movement around the rectangle is anti-clockwise, and the cases on the two pallets in the foreground have been completed. The operator, standing at the loading/unloading station, has already unloaded the preceding pallet and is using a clamping press to secure a new transmission case in position. This workpiece has just been

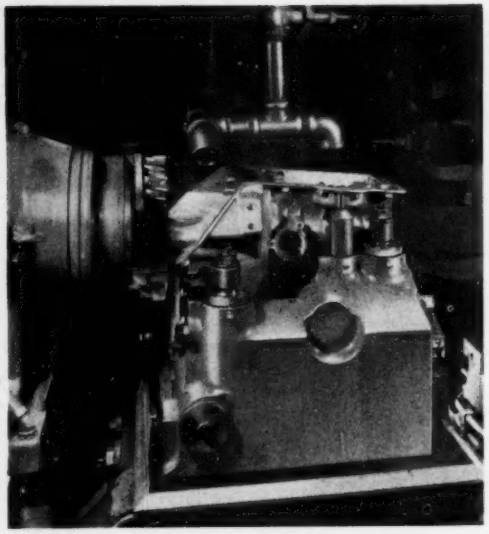

Fig. 4. A Small Cutter Carried by this Planetary Milling Head Covers the Entire Mounting Face of the Casing

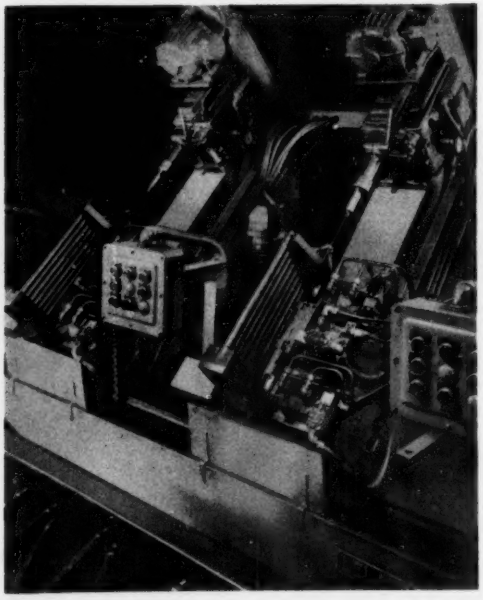

Fig. 5. On these Inclined, Deep-hole Drilling Machines the Work is Automatically Loaded and Discharged by Gravity

unhooked from the monorail conveyor (not visible) behind the operator.

There are certain advantages in this rectangular layout of the transfer machine. Since the pallets change their direction by 90 deg. at each corner, both sides and both ends of the transmission case can be presented to tool heads at various stages of the cycle. In addition, the rectangular arrangement saves floor space and enables pallet loading and unloading to be carried out at one station.

For indexing along the sides of the rectangle, the pallets are engaged by horizontal bars. The cylinder for operating the bar for the first side of the rectangle may be seen in the left-hand foreground of the illustration.

Certain surfaces are rough-milled or rough-bored as the castings move down the first long side of the rectangle, and are finished on the opposite side. Since the operating time at the finishing stations is about twice that at the roughing stations, two identical finishing lines have been provided on the second long side of the rectangle. As the pallets approach this side, they are automatically diverted to one line or the other, and after the finishing operations have been completed, they again converge into a single line. With this arrangement, a cycle time suitable for the faster roughing operations can be maintained.

One of the more unusual operations, illustrated in Fig. 4, is the finish planetary-milling of the large mounting face. A 5-in. shell end-mill, carried by a geared head, is moved in a circular path for machining this face.

INCLINED DRILLING MACHINES

The input shaft of the Turboglide transmission is machined from steel bar. At the first operation, the stock is turned, necked, chamfered, and cut off into 16-in. lengths on a 4-spindle Conomatic machine. Next, an oil-hole is drilled automatically through one end. Two of a battery of eight Leland-Gifford machines employed for this operation are seen in Fig. 5. They are grouped in two opposing banks, each comprising four machines, and are tended by a single operator.

As will be observed, the columns of the machines are inclined, to permit gravity feed and discharge of the work. A magazine, which is also inclined, is provided on each machine, and holds eight shafts. At the upper end of the fixture, in line with the lowest shaft, there is a bush for guiding the drill.

The $\frac{3}{8}$-in. diameter drill is of the slow-helix type, and as the hole is about 5½ in. deep, the spindle is retracted several times during the operation to clear the chips. As each shaft drops to the lowest

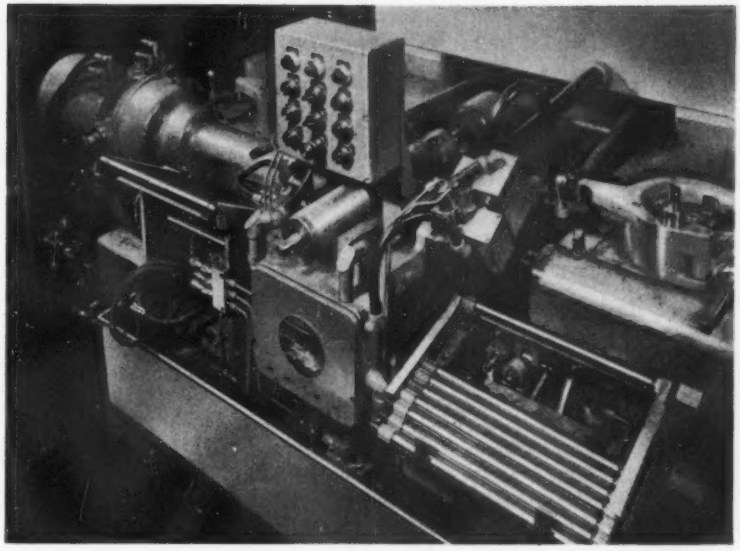

Fig. 6. On this Double-ended Horizontal Gear Shaper the Central Portion of the Work is Gripped in a Collet and Splines are Cut Simultaneously at Both Ends

position in the fixture, it is clamped mechanically.

Feed is applied to the spindle hydraulically, and when the final depth has been reached, the spindle is retracted and a micro switch is actuated, with the result that the clamp is released, and the shaft is ejected on to the belt conveyor seen in the foreground. This belt leads to another station, at which a ⅛-in. hole is drilled in the wall of the shaft at the bottom of the deep hole.

After the shafts have been heat-treated and ground, splines are cut at both ends. Four Fellows horizontal, double-ended gear shapers, stated to be the first of their type, are employed for this spline-cutting operation.

One of these shapers is shown in Fig. 6. Work loading and unloading, and cutter and work movements are automatic. Incoming shafts are stacked in a magazine at the left-hand side of the machine. For loading, the lowest shaft in the magazine is pushed into the collet of a centrally located chucking spindle. The collet grips the central portion of the shaft, leaving both ends exposed.

In the horizontal plane of the chucking spindle, and slightly behind it, are two opposed cutter-spindles. With a shaft in position, the chucking spindle rotates and the cutter-spindles reciprocate and rotate. In approximately 1 min., the 16 splines

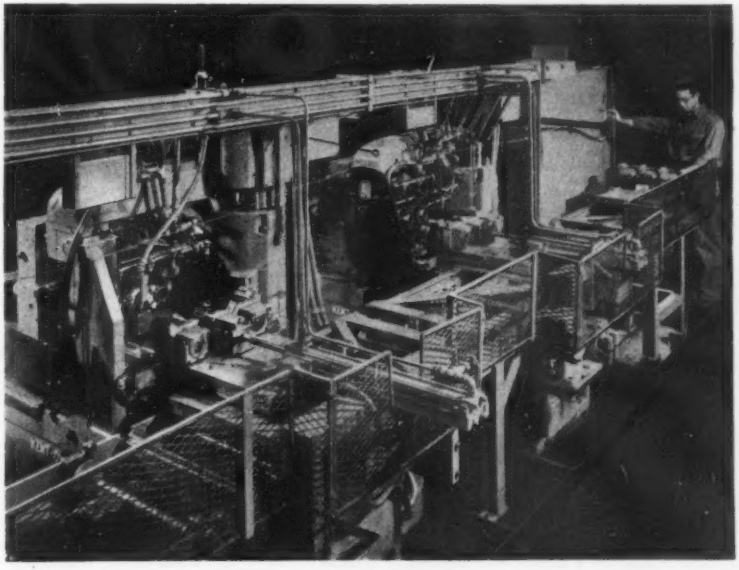

Fig. 7. The Workpieces are Automatically Changed from One Pallet to Another with this Transfer Milling Installation

at each end are completed, and the shaft is ejected into the discharge chute seen in the foreground.

Each shaping machine has an integral hydraulic system which provides for the reciprocating movements of the cutter-spindles, and the loading and ejection of the work.

WORK HANDLING EQUIPMENT FOR A TRANSFER-TYPE SLOT-MILLING MACHINE

Three other shafts in the transmission are produced from cold-drawn, seamless-steel tubing. One of these shafts is upset at one end, and after a series of machining operations it is seam-welded to a pressed steel drum to form the turbine shaft and front gear-ring hub assembly.

Machining carried out after welding includes two slotting operations on the drum section. These slots are milled on the Kent-Owens transfer equipment shown in Fig. 7. At six equally-spaced points around the drum periphery, closed slots are milled, and at four other equally-spaced points, open slots are milled. At each of the working stations there is a rise-and-fall milling machine. Three assemblies are processed together, three cutters being mounted on the arbor of each machine.

An unusual arrangement is employed for transferring the work from station to station. There are three hydraulically-operated pallets, each carrying a row of three work-fixtures, and in each fixture the drum section of an assembly is gripped. The first milling machine, which is a standard horizontal type, completes the six closed slots, and the second machine, arranged for hydraulic head feed, completes the four open slots.

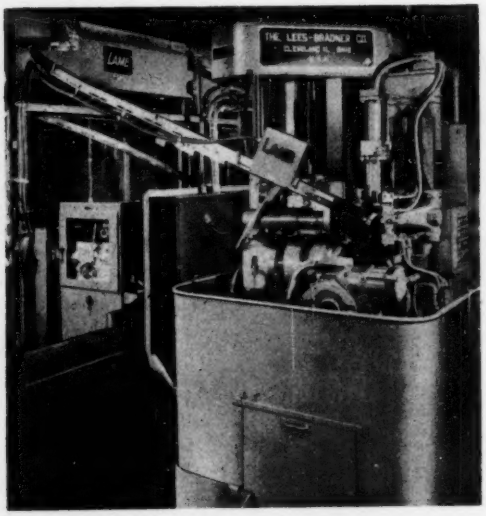

Fig. 8. One of the 20 Machines Employed for Hobbing the Planetary Gears. Each Machine Receives Blanks from Preceding Operations by way of a Lamb Work-handling System

As the work passes along the line, it is transferred from one pallet to the next. In the illustration, the operator, seen at the loading station, has placed new assemblies in the fixtures on the pallet in front of him and is about to start a cycle. At this moment, the slotting operations performed during the previous cycle have been completed, and the assemblies have been returned to pallets at the two work-stations.

When the next cycle starts, the pallets at the work-stations are retracted and moved to the left until the pallet which was at the second station is in front of an unloading station (not visible), and the pallet which was at the first work-station is in front of the second work-station. At the same time, the pallet at the loading station is moved to the left until it is in front of the first work-station and is turned through 90 deg. anti-clockwise. All three pallets are then advanced. The pallet at the unloading station ejects its assemblies, and the pallets at the two work-stations move up until the shaft sections of the assemblies are gripped in the collets of indexing fixtures beneath the milling spindles, and are then retracted slightly.

Next, the pallet movements are reversed, and they return to their original position, as illustrated. Milling follows, one slot at a time being cut in each drum, with the fixtures at the first work-station indexing 60 deg. for the closed slots, and the fixtures at the second station indexing 90 deg. for the open slots.

When all slots have been milled, the spindles are stopped, and the indexing fixtures release their grip on the shaft portions of the assemblies. The pallets at the two work-stations are then advanced, and the pallet fixtures retrieve the assemblies, gripping them by the drum portions.

AUTOMATIC GEAR PRODUCTION

Production of small planetary gears for the Turboglide transmission, which are required in large quantities, is expedited by elaborate material-handling and inspection arrangements between operations. The processing sequence provides for cutting off the gear blanks from bar stock, washing, face-grinding, face-honing, boring, hobbing, shaving, heat-treatment, tooth-chamfering, bore-honing, tooth-honing, and sound-testing. In all, 60 separate machine tools are employed.

All these machines are connected by an intricate

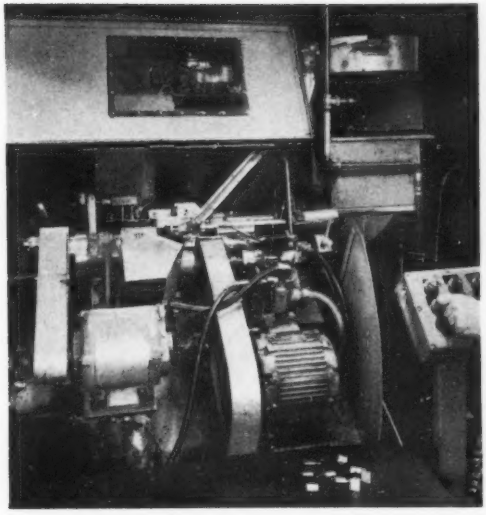

Fig. 9. On this Machine a Variable-pitch Stator Blade is Twisted, Drilled, Cut-off, and Broached. A Crank is then Pressed In and the Assembly is Ejected

network of Lamb conveyors, chutes, storage units, line switches and shot-bolt assemblies, which eliminate all manual work-handling, apart from loading the gears into baskets for heat-treatment. At numerous stages, provision is made for automatic inspection, and some of the machines are arranged for automatic feed-back correction.

One of the hobbing machines used in the planetary gear line is seen in Fig. 8. Blanks roll down a chute and advance to a loading station, and during the hobbing cycle 15 helical teeth of 20 D.P. are cut. After being automatically discharged down another chute, the gears roll into an elevator and are raised to a conveyor which distributes them to a battery of gear shavers. Before they are discharged the hobbed gears pass through an inspection station. The machine, a Lees-Bradner vertical single-spindle type, has a feedback arrangement for adjustment of the hob setting.

MACHINING VARIABLE-PITCH STATOR BLADES AND ASSEMBLING CRANKS

The variable-pitch stator employed in the Turboglide transmission incorporates a ring of small magnesium blades. Pitch is varied by means of a steel crank which is pressed into the body of each blade. A high degree of automation is achieved with a battery of Agnew machines which completely process the blades from lengths of extruded bar stock, and then locate and press in the cranks.

A close-up view of one of the machines is given in Fig. 9, where several blade-crank assemblies may be seen in the foreground. Extrusions of the required cross-section are fed in 20-ft. lengths into the left-hand side of the machine. When the bar abuts a stop, jaws clamp the end and at the same time twist the thin edge to the required helix.

While the bar is clamped, a carbide circular saw cuts off a blade. If the saw should break, an air gauge stops the cycle automatically. Next, a gun drill is advanced from the right-hand end of the machine and produces the hole for the crank. The blade, once severed, is moved upwards be-

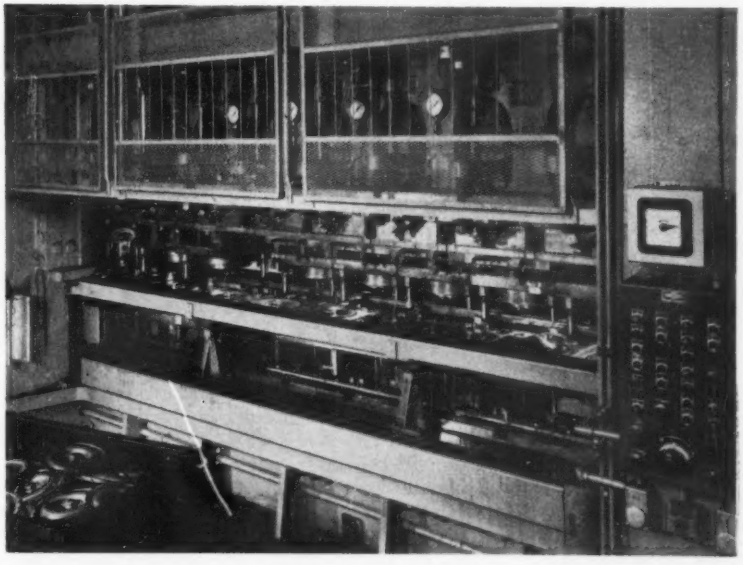

Fig. 10. Set-up on a 3,000-ton Transmat Press for Operations on Torque-converter Covers

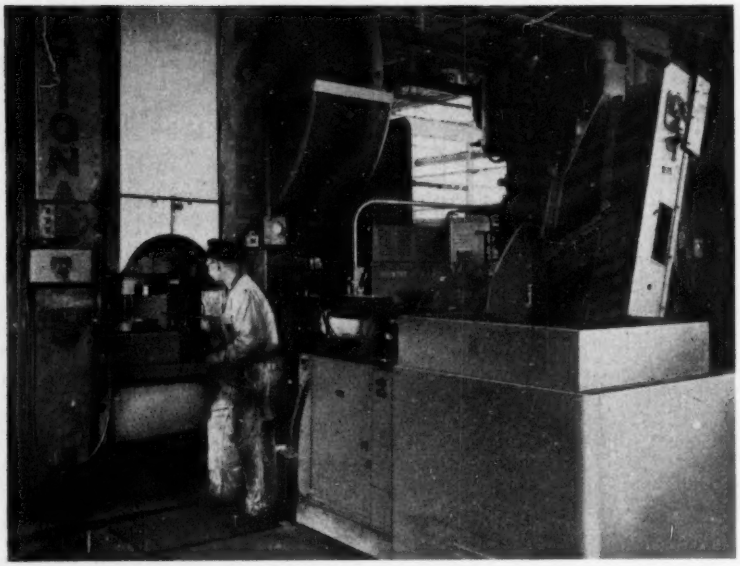

Fig. 11. Slugs for Planet Gear Spacer Forgings are Delivered Automatically from a Bin to an Induction Heating Unit

tween two stationary broaches which straddle the ends and control the length. One broach produces a square end, and the other, a curved end.

The blade has now reached a pressing station and is ready for assembly with a crank. Cranks are formed on a four-slide wire machine and then heat-treated. They flow down a chute from the hopper seen on the right-hand side of the Agnew machine. A mechanism aligns each crank with the hole in a blade body and locates the throw of the crank in the correct radial position. A punch then forces the crank into the hole. (To ensure a tight assembly, the periphery of the crank is serrated at the wire-forming operation.) The complete assembly is ejected by air.

Equipment installed in the Chevrolet-Toledo factory includes a Verson 3,000-ton Transmat press. Torque converter covers and all pans are produced on this press, and each part requires a series of forming and piercing operations.

Part of the torque-converter set-up may be seen in Fig. 10. There are two slides and bolsters, separated by centre columns at the front and rear. In the area between the columns a turn-over device is provided. Work is progressed through a series of eight stations covered by the right-hand slide, inverted as it passes between the centre columns, then passed through a series of stations covered by the second slide.

The blank for the cover is a 14½-in. diameter steel disc, 0·224 in. thick. Tools, at the various stations covered by the first slide, draw the body to a hat shape, then reduce the size of the "crown" portion, develop the body contour and centre, and finally form the flange. After the cover has been inverted, the tools in the second section of the press restrike the flange and pierce a circle of holes in the flange.

In the forging area of the factory further evidence is afforded of the emphasis placed on manufacturing efficiency. Presses and upsetting machines are arranged to minimize handling.

In Fig. 11, a planet gear spacer is being forged on a 1,300-ton National Maxipress. Slugs from the bin in the foreground travel up a KDI elevator, and are delivered into a chute leading to a Tocco induction heating unit. With a minimum of motion, the operator removes a slug, after it has been rapidly brought to forging temperature, and places it in the right-hand blocking impression. For the second operation the work is placed in the left-hand die, and is finally transferred to the central die. Finished forgings roll down a chute at the rear, in a trimming press.

INSPECTION BY MINIATURE RADIOGRAPHY. It is reported that the Battelle Institute have found X-ray examination effective for determining the causes of failure of miniature electronic components. Items inspected, which include diodes, transistors, capacitors, silicon rectifiers, and photodiodes, are about 0·25 in. long. The radiographs are enlarged photographically ten times to facilitate observation, and it is stated that defects such as burned-out leads, displaced capacitor elements, and separations can be detected. It is pointed out that if these small fragile devices are dismantled for direct visual inspection after failure there is considerable risk of destroying the evidence that is being sought. Components can also be inspected radiographically prior to testing.

Technical Education for Production Engineers

The 1957 Viscount Nuffield Paper of the Institution of Production Engineers was presented by the Rt. Hon. Lord Hives, C.H., M.B.E., D.Sc., Ll.D., at the University of Bristol on February 6. Lord Hives, it will be recalled, was, until early last year, chairman of Rolls-Royce, Ltd., and at the present time is chairman of the National Council for Technological Awards. In his paper, which was entitled "Technical Education for Production Engineers—Some Reminiscences and Experiences," Lord Hives not only considered technical education as such, but also some of the problems that he had experienced, which demanded technically trained staff.

He emphasized that the problems of production started when the first lines of a design were put on paper, and stated that, in his opinion, a designer should also be a production engineer. He strongly disagreed with the suggestion, which was sometimes made, that an article could be designed and developed, and then handed over to another group of people who would "productionize" it. If such a course had been adopted for products with which he had been associated in the past, the results would have been disastrous, and he considered that all the available talent and knowledge should be used to ensure that the original designs were practical from a production standpoint. The adoption of such a course might mean that more thought would have to be given to the original designs, but the eventual result would be a saving in time. He had been brought up to believe in the maxim "think before, not after," but this simple and wise philosophy was often neglected.

The desired unity of design, development, and production could only be achieved if the various members of the team responsible for a design had confidence in, and respect for, each other. Frequently, criticism was levelled against designers for demanding large numbers of modifications after the manufacture of a product had begun. Many of these changes were suggested by production or service departments, and Lord Hives considered that if a product was to be kept up to date and the criticisms of customers met, such changes were inevitable. He stated, moreover, that he would feel much more concerned if no changes were made.

PROBLEMS OF AMERICAN PRODUCTION OF BRITISH DESIGNS

Lord Hives referred at some length to the production of Rolls-Royce Merlin engines by the American Packard Company. Altogether, 55,000 Merlin engines were produced in the U.S.A., the approximate cost of the whole project was 700 million dollars, and, at the peak, output of Merlin engines was 100 per day. The initial contract with Packard was signed in September, 1940, and that company undertook to deliver the first complete engine within twelve months. In fact, the first Packard engine was produced in September, 1941, and by March, 1942, engines were being delivered at the rate of 500 per month. One of the major problems that had to be overcome related to the working drawings, since those supplied by Rolls-Royce were made to first-angle projection, which was British standard practice, whereas the American Standard was third-angle projection. To avoid confusion in their workshops, which were accustomed to the American standard, Packard decided to re-draw each of the 2,000 to 3,000 drawings.

Another important decision related to screw threads, since those in the British Merlin engine were to Rolls-Royce standards. Packard decided to adopt this standard, although it meant that Merlin engines supplied to the U.S. Army Air Force would have threads that were not to American standards. This decision, moreover, not only affected Packard factories, but large numbers of outside suppliers. Allied with the decision on the screw threads was a similar decision to retain Rolls-Royce standard hexagons, for nuts, bolts and similar parts, so that the spanners and tool kits complied with British designs. Considering the Packard undertaking in retrospect, Lord Hives continued, it was gratifying to note that the project went through so smoothly, in spite of the potential hazards and difficulties. Any difficulties that did arise were overcome by co-operation within, and between, the Packard and Rolls-Royce organizations. The Packard Merlin project demonstrated that an essentially British design could be produced successfully in the U.S.A., in large quantities.

Merlin engines were also produced during the war by Ford Motor Co., Ltd., in a factory at Manchester. Up to the end of 1945, the Ford

Company delivered approximately 30,000 engines, and, in the latter half of 1944, they were consistently producing 900 engines a month. It was interesting to note that there was never any question about the quality of engines produced by Ford, and they were considered to be equal to any that were made by Rolls-Royce.

Referring to the production of other Rolls-Royce engines abroad, Lord Hives mentioned that in 1947 Pratt & Whitney, in the U.S.A., were granted a licence to produce Rolls-Royce Nene jet engines. Again, difficulties arose concerning drawing projection, and all the major drawings had to be re-drawn. Pratt & Whitney used Rolls-Royce standard screw threads and hexagons, also the Lucas fuel system which was standard on Rolls-Royce engines. Subsequently, Rolls-Royce developed the Tay engine, but dropped it in favour of the Avon. The Tay engine was developed by Pratt & Whitney, and was known in the U.S.A. as the J.48. On this engine, Pratt & Whitney employed their own standard for threads, hexagons, and similar items.

USE OF METRIC SYSTEM

In 1953, Westinghouse, in the U.S.A., took out a licence for the production of Rolls-Royce axial jet engines, which was still in operation. On the Continent, Rolls-Royce engines were being built by Hispano in France; Fabrique Nationale in Belgium; and Flygmotor in Sweden. At an early stage, Hispano requested that they should be supplied with drawings which had metric dimensions. Rolls-Royce could not undertake this work, and eventually a compromise was reached whereby all dimensions on the Rolls-Royce drawings were translated into metric values, by using a factor, and certain odd metric sizes had to be accepted. Later, the French Air Force insisted on the adoption of metric spanner sizes, so that the dimensions of nuts on Hispano engines differed from those on British engines. The Tay engine was also developed by Hispano, and was known as the Verdun. This engine was being produced in France at the present time. The Belgian F. N. Company had delivered approximately 1,000 Derwent engines, and again drawing sizes were converted to metric by the use of a factor. Drawings for the engines built by Flygmotor had metric dimensions, but all screw threads, and nuts, were to British dimensions. The production of Rolls-Royce engines by other countries in various parts of the world, Lord Hives emphasized, had shown that quality of workmanship was not the monopoly of any one country. Provided that the desire was there, the necessary high standards of accuracy could be, and had been, achieved.

Referring to the use of the metric system, Lord Hives pointed out that Continental manufacturers were firmly committed to metric sizes and although they accepted the compromise of converting British dimensions to metric, they had shown no desire to change over to the inch system. He remarked that Russia, China, India and Japan, had all adopted, or were adopting, the metric system, so that the inch system of measurement was losing ground. If, and when, the European Common Market, or Free Trade Area, became established, Britain would be placed in an increasingly difficult position if it was the only country in Europe not using metric dimensions. The situation was further complicated, he pointed out, by the recent adoption of the unified thread system.

Due to their experiences with American manufacturers, Rolls-Royce had decided to change over completely to the third-angle projection system for all drawings used in the aero engine, motor car, and oil engine divisions; also for all jig and tool drawings. He, personally, considered that it would be desirable if some world-wide agreement could be reached on the comparatively simple issue of drawing projection.

Continuing, Lord Hives referred to the costs of Rolls-Royce engines made by the parent company, and by licensees. During the war, there was an excellent opportunity to compare costs, since large numbers of identical parts were being made on similar equipment. Unfortunately, it was only possible to investigate the production of one part, and it was found that, over a fairly long period, there was no significant difference in the costs for the production of this part at different plants. Lord Hives stated that his experience had taught him that if one was not satisfied with the efficiency of a factory, one should investigate the management. If one was still not satisfied, one should investigate the management again, and only then should one tackle the man on the shop floor.

Turning to the subject of technical education, Lord Hives pointed out that technically-trained graduates who were engaged by Rolls-Royce some 25 to 30 years ago, now filled the posts of technical director of the company; managing director, chief engineer, and general manager of the Motor Car Division; managing director of the Oil Engine Division; and assistant chief engineer of the Aero Division. Although he considered that technical training was all-important, his own investigations had led him to believe that no particular method, or place, of training could be considered to be the best, since so much depended upon the individual. He felt that the final responsibility for training the majority of technologists would always rest with industry, and that the amount of money that

industry was spending yearly on education was not widely recognized.

SHORTAGE OF DESIGNERS

He went on to express the opinion that the most serious shortage at the present time was not of scientists, but of creative designers. The first qualification for design work was experience, and technical qualifications were not, in themselves, sufficient. Adequate drawing office experience and practical training were essential. He regretted that university graduates usually did not take kindly to drawing office work, and sought more glamorous careers in research, development and testing. Industry was largely responsible for this situation, since insufficient encouragement was given to first-class designers.

Technical training in industry, he pointed out, was a long-term and expensive process. It was a generally-accepted procedure that all graduates, whatever their qualifications, served two years in a factory before they were selected for any particular job. He believed, however, that the so-called "thick sandwich" scheme offered advantages. Under this scheme, a student was selected by an industrial concern, and spent one year in a factory before he entered a university. After three years at a university, he spent a further year in industry before his initial training was considered to be complete. A student, he considered, was likely to make much better use of his opportunities at a university if he had seen the inside of a factory, and was sponsored by an industrial organization.

TRAINING FOR THE DIPLOMA OF TECHNOLOGY

The training arrangements for the new Diploma of Technology were based on the "sandwich system," but students would carry out their studies at the College of Technology and not at a university. The generally-accepted plan was that students should be sponsored by industrial firms and should spend six months in a factory and six months in a college, over a period of four years This arrangement had been applied in Scotland for many years, and had proved successful. Lord Hives believed that the Diploma of Technology courses would increase the supply of qualified technologists. He hoped, moreover, that the courses would gather in some brilliant people, who, at present, were not going to universities. He felt that, in the forseeable future, there would be a steady increase in the amount of sheer knowledge that the technologist would have to acquire, with the result that much more would be demanded of our educational facilities. Not only should the time allotted for learning be extended, but the quality of education should be raised.

The objective of the National Council for Technological Awards was to guarantee and safeguard the quality of the Diploma of Technology and any higher diploma that might be introduced. Obviously, the quality of the qualification could not be ensured without some supervision of the facilities provided by educational authorities. It had been found that the standard of equipment, libraries, buildings, and other facilities was low compared with those available overseas, and that there was a general lack of student amenities, such as playing fields, common rooms, and study facilities. The qualifications of those teaching technological subjects, moreover, were not generally as high as one would have wished.

Although some technical colleges complained that they had little support from industry, many colleges had no representatives of industry on their governing bodies. Industry should strive to correct this situation, for it might well be that every course held by a college was intended to meet the needs of some industry.

The work of the National Council for Technological Awards had resulted in some encouraging improvements. Since the training arrangements for the Diploma of Technology scheme had been placed under the charge of an independent body, they were completely free of the influence of traditional methods of teaching. The Council worked closely with industry, and included a fairly large number of industrialists. Its deliberations were greatly assisted by the expert knowledge of factory organization that such industrialists contributed. The Council would ensure that the technical colleges in this country developed on their own lines, which would, no doubt, be different from those followed on the Continent, but none the less efficient. Eventually, he was quite sure, they would take a greater share in our industrial and commercial life.

TECHNICAL EDUCATION AND THE FUTURE

Lord Hives stated that it was now generally accepted that this country had fallen behind as regards technical education, due to neglect over the past 10 to 15 years. He was confident that the universities would catch up with world conditions, but he felt that they should regard this matter as one of great urgency. In his opinion, the universities still suffered from "built-in drag" from the classical faculty. He considered that the time had passed for discussing the merits of a classical, or scientific, or technological education.

Applied science was part of our everyday life. If, in trying to meet the demand for more technically-trained workers, we lowered our standards, we should achieve nothing. It was necessary to ensure that the best brains and the most brilliant scholars took up a technical career if we expected to maintain the present standard of living in this country.

One of the criticisms levelled against technical education was that it was too narrow, and that the syllabi should include more liberal studies. This criticism had been accepted, but it was difficult to decide what should be given up in the technical field to make way for such studies. It was often stated that the reason why a large number of industrial firms had non-technical people at the head, was because the outlook of members of the technical staff was not sufficiently broad. Lord Hives could not subscribe to this opinion, and suggested that the reason was that technically-trained staff were so valuable that they could not be spared to undertake non-technical jobs when other people were available. This situation, he considered, would correct itself as the number of technically-trained men grew.

Referring to the international situation, Lord Hives stated that his principal concern was not with a future war, but with the competition that we could anticipate from Russia in the industrial markets of the world. The possibility of such competition was already apparent, and when the challenge became really serious, it would have to be faced by British industries. If the quality and prices of our products were not then competitive we should be forced out of business. The recent successes of Russian scientists and technologists were not due to accident or luck, but were the results of planned policy over the last 25 years, and he considered that we had not yet found an adequate answer. The professors and teachers of technical colleges were among the highest paid people in Russia; their salaries were larger than those of the leaders of industry, and they enjoyed a greater social standing. He doubted whether we had really faced up to this situation. Many people, Lord Hives considered, paid lip service to the necessity for scientific and technical education, but did not really believe in it, and science and technology were frequently regarded as upstarts which disturbed the peace and tranquillity to which such people had become accustomed. Socially, it was still thought that industry was something with which the best people should not be connected.

In conclusion, Lord Hives stated that he would not believe that this country was serious in its endeavours to produce more scientists and technicians until the universities and the technical colleges worked more closely together. In whichever direction one looked, people, in this country, were short of knowledge. We could not expect to compete with the U.S.A. and Russia, in numbers, but we should do everything that was in our power to compete with those countries in quality.

Trade Publications

THE MAGNETIC EQUIPMENT CO., LTD., Lake Works, Portchester, Hants. Leaflet concerned with Magco bowl feeders and spiral elevators.

RICHARDS STRUCTURAL STEEL CO., LTD., Phoenix Iron Works, Leicester.—Folder describing the Thorite motorized driving drum for conveyor belts.

MUIRHEAD & CO., LTD., Beckenham, Kent. Folder with illustrations and tabulated data for the company's extensive range of synchros, servomotors, resolvers, motor tachometers, and tachometer generators.

CLAYTON ENGINEERING CO., Cannhall Works, Cannhall Road, Leytonstone, London, E.11. Brochure describing the range of Clayton indicators for precision setting of rotary controls, as may be required, for example, for reduction gear units, machine adjustment, and valve regulators.

B. & S. MASSEY, LTD., Openshaw, Manchester, 11.—Fully illustrated booklet entitled "pneumatic power hammers with slides." These hammers are available in a range of sizes with "falling part" weights from 1 to 10 cwt., and the principal features and advantages are discussed.

LAFARGE ALUMINOUS CEMENT CO., LTD., 73 Brook Street, London, W.1. Booklet, specially prepared for the maintenance engineer, concerned with Ciment Fondu. Sections are included under the headings: concrete in hours—not days; corrosion-resistant concrete; refractory concrete; and heat-insulating concrete.

THE KINGSLAND ENGINEERING CO., LTD., 25-37 Hackney Road, London, E.2. Leaflets concerned with the following new products which are being introduced by the company: Handy rod and wire cutting machines; Handy angle iron cutting machines; and Flex portable sheet metal shears and nibblers.

TORNOS SALES CO., Broadgate House, Coventry. Attractively illustrated folder giving brief particulars of the Tornos range of sliding head automatics with maximum bar capacities from $\frac{3}{32}$ in. to $1\frac{3}{32}$ in. Typical parts produced on these machines are also shown, together with equipment which can be supplied to facilitate cam layout, production, and measurement.

GEORGE KENT, LTD., Luton, Beds. Leaflet describing the Mark 2A electronic Multelec recorder which was developed for the atomic-energy industries and previously reserved for sale in this field. The recorder is now generally available and can be employed for temperature measurement; direct millivoltage recording; for industrial measurements depending on a radioactive source and ionization gauge; and for research work.

News of the Industry

Tyneside

SHIPYARDS on the River Tyne still have large tonnages on order, although the new bookings in the last quarter of 1957 were considerably less than in the first quarter. The same applies to the marine engineering shops and to the suppliers of auxiliary equipment. There is much activity in connection with steam power plants for electricity undertakings, nuclear power stations and other users, and switchgear manufacturers also have good order books. Last year, for the first time, the North-East region replaced South Wales as Britain's foremost steel producing area, with 4·35 million tons of steel and 3·1 million tons of pig-iron. Expansion continues, and the South Durham Steel & Iron Co., Ltd., are spending £45,000,000 on extensions at West Hartlepool, and Dorman, Long & Co., Ltd., are building a plant at Lackenby, near Middlesbrough, which will cost £50,000,000. Machine tool makers in the area have good order books, but for certain lines new business, for some time, has been on a reduced scale.

NOBLE & LUND, LTD., Felling-on-Tyne, have a big programme of heavy machine tools on order, including lathes of 21-, 27-, 30-, 36-, 68- and 72-in. centres, and a combined lathe and boring machine to swing 11 ft. diameter. In addition, we may note planing machines of 20 by 15 ft. and 26 by 14 ft. and a rail planer, also plano-milling machines of 20- by 8- by 6-ft. capacity. Other work includes 6-in. spindle horizontal boring and milling machines and turbine case boring machines. Our attention was drawn to a recently-completed double duplex beam end milling machine which is destined for India. Since our last visit a new brass turning shop has been added, and extensions have been made to the electrical equipment and turning sections of the works. It is proposed to extend the foundry by another 200 ft.

Orders for Fluifeed sawing machines, on both home and export account, including both horizontal and vertical types, equipped with saws up to 72 in. diameter, are again more numerous after a quieter spell. A new range of horizontal sawing machines in sizes of 20/22, 24/23, 30/38 and 40/48 in. has recently been introduced, also a 48-in. vertical sawing machine, to which we hope to make further reference at a later date. Recent plant additions include an Orcutt hydraulic gear grinding machine, a Heidenreich & Harbeck bevel gear generator, a Dean, Smith & Grace toolroom lathe, a Precimax cylindrical grinding machine, and a broaching machine.

LUMSDEN MACHINE CO., LTD., Gateshead, are

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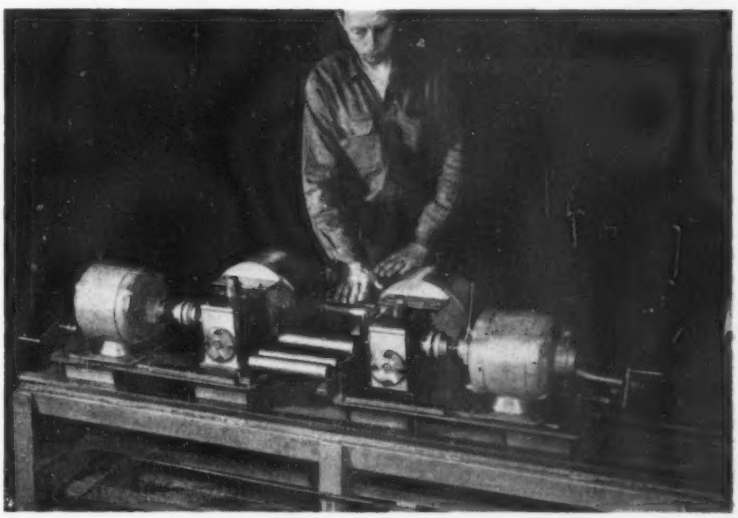
The equipment here shown is employed at the works of the Wolverine Tube Division, of Calumet & Hecla, Detroit, Mich., U.S.A., for deburring the ends of copper and brass tubes. There are two opposed assemblies, each consisting of a pair of brushes, a motor, and a right-angle gear drive, and as the tubes pass the brushes, they are automatically rotated. The assemblies are mounted on movable bases so that they can be adjusted to accommodate workpieces of various lengths



occupied with the production of standard reciprocating and rotary table surface grinding machines, the latter ranging up to 100 in. table capacity. In addition, orders are in hand for retractable rotary table machines of 36-in. capacity, continuous-type surface grinders for the motor car industry, slideway grinders, and machines for die grinding. Other work includes oscillating tool grinders, and 2- and 4-wheel cemented-carbide tool grinders. We may note recent export business with India, Australia, South Africa and Spain. Extensions to the machine shop at these works are projected.

LERCHE MACHINE TOOLS, LTD., Oakwellgate, Gateshead, report a steady demand for the various British and Continental machine tools which they market. Among the latter we may note Heidenreich & Harbeck bevel gear generators, Staehely gear hobbing machines, and Carl Mahr instruments. Our attention was drawn to the new Carl Mahr Supramess comparator, of extreme sensitivity, to which we hope to make further reference shortly. Another new line, to which we hope to refer again, is the Rentsch hydraulic chamfering machine for the ends of the teeth of spur and helical gears. The machine operates fully automatically and has electrically-controlled hydraulic drives.

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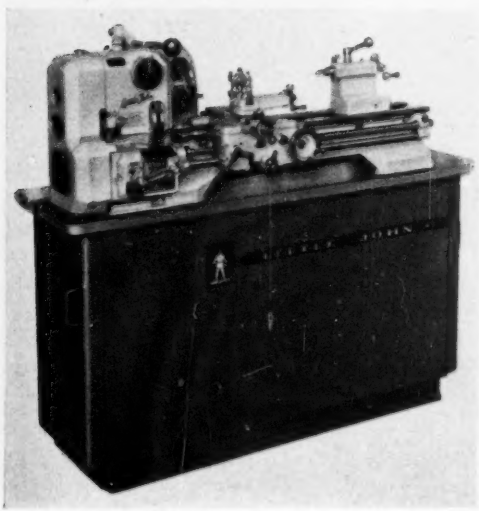
The Little John 5-in. centre lathe made by Raglan Engineering Co. (1954), Ltd., is now provided with a full length, sheet-metal cabinet base. There are two end cupboards, with shelving, for the storage of tools and equipment



CHURCHILL GEAR MACHINES, LTD., Blaydon-on-Tyne, are well employed on the production of gear hobbing and gear shaving machines. Five of the latter machines have recently been ordered by a French motor car works. Greater scope for the sale of Red Ring machines in Western Europe has recently been afforded. Orders are in hand for a number of the new S1418 Rigidhobbers, a description of which was published in MACHINERY, 91/1457—20/12/57. An interesting, automatic loading, transfer-line hobbing machine in progress for Ford Motor Co., Ltd., comprises nine individual machines for dealing with three sets of cluster gears simultaneously. Other activities include the production of gear sound testing machines and shaving cutters, for which a steady demand is maintained. Recent additions to the plant include Churchill Rigidhobbers, a Planers (Huddersfield), Ltd., planing machine of 12- by 5-ft. square capacity, and a Churchill 48-in. AC-type internal grinding machine.

VICKERS-ARMSTRONGS (ENGINEERS), LTD., Elswick, Newcastle-on-Tyne, have several British Clearing mechanical presses on order for motor car body building firms, mainly in the 350- to 450-ton range. We may note a 1,000-ton press destined for a safe manufacturing firm. Other work includes hydraulic presses of 100- and 250-ton capacities, a 150-ton hydraulic press brake, hydraulic die-spotting presses, and a hydraulic crankshaft twisting machine for Sheffield. Export orders are in hand for Australia and Sweden. A substantial proportion of the contract obtained by Davy and United Engineering Company, Limited, Sheffield, for new rolling mill equipment required by the South Durham Steel & Iron Co., Ltd., has been allocated to this firm.

The British Clearing machines are marketed by the Rockwell Machine Tool Co., Ltd.

T. B. PEARSON & SONS, LTD., Wincomblee Road, Low Walker, Newcastle-on-Tyne, are experiencing a brisk demand for electro-hydraulic guillotine shearing machines and flanging presses, and we may note export business with Canada, New Zealand, Southern Rhodesia, Sweden, Spain, India and the Philippine Islands. Sizes of the former range from 6-ft. by ⅜-in., up to 12-ft. by 1-in. capacity, and of the latter, from 70- to 500-ton capacity. Our attention was drawn to 10-ft. by ⅝-in. and 12-ft. by ¾-in. guillotine shears destined for North-East Coast engineering works, and to a 12-ft. by ½-in. guillotine shears

and a 10-ft. by 150-ton flanging press for export to India. We hope shortly to make further reference to a 500-ton hydraulic, general-purpose, open-fronted press, which is nearing completion in the works.

There is a good call for fabricated steelwork, and contracts are in hand, for example, for 900 tons of circulating pipework for one of the power stations of the Central Electricity Authority, several large stators for nuclear power stations, steelwork for overseas power stations, and oil drilling platform equipment for Trinidad. Among the machine tool plant installed we noted a Noble & Lund 24- by 16- by 8-ft. planing machine.

H. B.

London and the South

HICKS MACHINERY, LTD., 26 Addison Place, London, W.11, are agents for the Magdeburg D.30 production lathe and the D.H. 300 semi- or fully-automatic lathe, both of which are said to be finding increased application among users in this country.

Several well-known firms, engaged in production of components for electrical, optical, and other precision equipment, have installed Magdeburg lathes, on which parts of consistent accuracy are made by semi-skilled operators. Boehringer-Sturm hydraulic steplessly-variable drives can be fitted, when required, to D.30 lathes, to provide spindle speeds from 60 to 1,800 r.p.m. The company also supplies overhauled used machine tools to the home and export markets.

TOLIMIT GAUGES, LTD., 16 Peterborough Road, London, S.W.6, are busy with the production of a comprehensive range of plug, ring and caliper gauges; air gauges; comparators; and machine control equipment for application to grinding machines, for automatically maintaining work size. This company's products are used widely by instrument manufacturers and in the ball bearing and motor vehicle industries. New plant has recently been installed to facilitate the production of screw plug gauges with hard chrome surfaces, and we are informed that such gauges can now be supplied in all sizes.

K. & L. STEELFOUNDERS & ENGINEERS, LTD., Dunhams Lane, Letchworth, are busy with the production of steel castings and the manufacture of the well known Jones mobile cranes. Founded in 1915, this company has continued to expand and improve facilities for the production of steel castings and their subsequent machining. The main foundry, it is claimed, is one of the most modern in the U.K. and contains efficient handling equipment and large capacity electric arc furnaces. In the machine shops a comprehensive range of modern machine tools is installed. Other departments include fabricating and welding shops, heat treatment bays, research and development laboratories, and test shops.

F. W. H.

Register of M.V. Ex-apprentices

Metropolitan-Vickers Electrical Co., Ltd., Trafford Park, Manchester, 17, have issued a fourth edition of their Register of Ex-apprentices and Ex-trainees. This remarkable publication, which extends to 700 pages, includes an alphabetical register of more than 13,000 men and women who have been trained as apprentices by the company during the period 1902-1956. For each, a brief biography has been given where possible, also the present address, if known. In addition there is a geographical index showing countries, counties or other districts, and towns, with the names of those resident. Accompanying this section, there are coloured charts and maps indicating the numbers of apprentices from, and numbers of ex-apprentices resident in, various countries and districts. The third main section of the book is a chronological index and gives the names of apprentices who started their training in various years at the various works of the company. Where appropriate, college, school, special, trade, and vacation apprentices are listed separately, also special trainees.

There is a number of relevant illustrations, including some in four colours.

A most impressive record of engineering training is here presented and the compilers are to be congratulated on the manner in which a task of such magnitude has been accomplished.

Machine Tool Exhibition at Cardiff

A. A. Jones & Shipman, Ltd., inform us that they are organizing an exhibition of machine tools, small tools and equipment at the Bowchier Memorial Hall (Institute for the Blind), 20 Newport Road, Cardiff, from February 24 to March 1. Exhibits will include precision cylindrical and internal, circular form-tool, plain cylindrical, and hydraulic surface grinders, and Slot-Hydromil hydraulically-operated slot milling machines.

An 11-in. swing lathe will be installed to demonstrate the J. & S. range of lathe tools and equipment, particularly the Jones-Shipman-Edibrac "throw-away" tip tool-holders. Engineers' small tools and equipment on view will cover a wide field from angle plates to machine vices.

The exhibition will be open daily from 9.0 a.m. to 6.0 p.m.

Geo. Bray Memorial Lecture

The 1957 George Bray Memorial Lecture of the Institution of Production Engineers will be presented by Dr. V. E. Yarsley, M.Sc., D.Sc. Tech. (Zurich), F.R.I.C., F.P.I., M.I.Chem.E., director of V. E. Yarsley (Research Laboratories), Ltd., and a past president of The Plastics Institute. Dr. Yarsley's subject will be "The Fabrication of Plastics," and the lecture will be delivered in the Chemistry Lecture Theatre "A," University of Leeds, on March 24, at 6.30 p.m., with Mr. J. E. Hill, vice-president of the Institution, in the chair. This meeting will be open to both members and non-members of the Institution. Admission will be by ticket only and early application should be made to The Secretary, Institution of Production Engineers, 10 Chesterfield Street, London, W.1.

New Companies Registered*

ARTHUR WOOD STEEL CO., LTD., 19 Bradfield Road, Sheffield. Registered February 5, 1958. To carry on the business of steel and iron forgers, etc. Nom. cap.: £1,000 in £1 shares. Directors: T. Green and T. E. Green.

PRODUCTION TOOL CO. (NOTTINGHAM), LTD., rear of 37 Thames Street, Bulwell. Registered January 15, 1958, to carry on the business of precision engineers, etc. Nom. cap.: £3,000 in £1 shares. Directors: G. F. Byron and Mrs. J. E. Byron.

H. T. BRIGHAM & CO., LTD., Station Road, Coleshill, Warwicks. Registered February 5, 1958. To take over the business of metal presswork and toolmakers carried on as "H. T. Brigham & Co.," at Coleshill, Warwicks., and also at 176 Berners Street, Lozells, Birmingham, etc. Nom. cap.: £10,000 in £1 shares. Permanent directors: H. T. Brigham and F. E. Brigham.

METALLIC INDUSTRIAL COMPONENTS, LTD., 18 Southampton Place, London, W.C.1. Registered January 31, 1958. To carry on the business of engineering component manufacturers, etc. Nom. cap.: £10,000 in £1 shares. Directors: T. F. Watson, R. H. Hargreaves and W. J. Dixon (chairman).

CASTINGS AND SMELTERS, LTD., 173 Walsall Road, Cannock, Staffs. Registered January 20, 1958. Nom. cap.: £5,000 in £1 shares. Director: G. E. Oakley.

SAMUEL LANGTON & SONS, LTD., Mersey Brass Works, Heaton Lane, Stockport. Registered January 17, 1958. To take over the business of brass founders carried on at Stockport as "Samuel Langton & Sons." Nom. cap.: £15,000 in £1 shares. Directors: S. Langton, Mrs. D. Langton, and H. Evans.

* From the lists compiled by Jordan & Sons, Ltd., Company Registration Agents, 116-118 Chancery Lane, London, W.C.2.

Memorial Service

A memorial service for the late Sir Holland Goddard will be conducted by the Right Reverend The Lord Bishop of Leicester, in Leicester Cathedral, starting at 2.45 p.m. on February 20.

Machine Tool Exports and Imports

EXPORTS OF MACHINE TOOLS

Type of Machine	Month ended November 30, 1957	Eleven months ended November 30	
		1956	1957
	Value £	Value £	Value £
New, complete—			
Boring machines:			
Vertical	47,011	420,358	455,132
Other	43,744	527,052	800,705
Drilling machines	164,891	1,705,083	1,906,607
Grinding (excluding thread grinding), lapping and honing machines	274,077	2,215,479	2,549,212
Lathes:			
Automatic	77,597	1,665,334	2,026,425
Capstan	174,366	2,106,088	2,439,313
Other	298,644	2,606,318	3,121,296
Screwing machines	17,290	185,291	196,968
Threading machines	20,571	377,416	536,202
Milling machines (excluding thread-milling) and gear-cutting machines	151,557	1,817,156	2,268,786
Planing, shaping and slotting machines	44,374	698,258	713,002
Presses:			
Hydraulic	100,790	1,763,466	1,298,837
Other	200,231	574,082	1,132,459
Punching and shearing machines	13,507	241,531	395,943
Other plate and sheet metal-working machines including straightening rolls	24,203	228,133	354,354
All other machines	301,174	2,008,958	2,812,370
Used machines, complete	28,461	970,058	726,714
Parts	280,050	1,664,919	2,286,488
Total	2,262,538	21,774,980	26,020,813
Destination			
Union of South Africa	150,852	1,188,641	1,504,513
India	256,730	2,422,620	3,208,168
Pakistan	12,870	256,435	180,707
Australia	308,281	3,499,572	3,716,627
New Zealand	46,544	363,919	369,675
Canada	263,946	2,018,534	2,089,860
Other Commonwealth countries	135,614	1,297,908	1,278,431
Soviet Union	174,799	727,898	1,012,708
Sweden	55,347	942,615	754,595
Netherlands	45,647	746,109	721,356
France	129,064	1,681,059	2,001,520
Spain	92,889	842,129	1,310,598
Italy	32,594	389,049	810,256
U.S. America	145,518	1,372,388	2,498,961
Other foreign countries	411,843	4,026,104	4,562,838

IMPORTS OF MACHINE TOOLS

New, complete—			
Boring and broaching machines	210,048	2,055,243	2,252,822
Drilling machines	26,704	292,529	388,697
Gear-cutting machines	100,450	1,025,021	886,842
Grinding, lapping and honing machines	258,370	2,884,052	2,087,959
Lathes:			
Automatic	316,999	2,656,662	2,237,499
Other	27,424	405,820	240,914
Milling machines	270,576	3,228,648	2,454,773
Planing, shaping and slotting machines	35,034	430,831	306,787
Presses	169,862	1,056,023	943,743
All other machines	226,008	5,137,818	4,584,354
Used machines, complete	41,713	758,140	320,778
Parts	242,509	3,270,655	3,593,714
Total	1,925,697	23,201,442	20,298,882
Country of Origin			
Western Germany	991,196	7,622,161	7,973,855
Switzerland	217,489	2,557,629	2,582,660
U.S. America	383,764	9,463,678	6,652,979
Other foreign countries	333,248	3,557,974	3,089,388

Books Received

METROLOGY OF GAUGE BLOCKS. National Bureau of Standards, U.S. Department of Commerce, Washington, 25, D.C. 119 pp. [Price 1.50 dollars, net.]

Contained in this volume are the proceedings of a symposium on gauge blocks, held during August, 1955, at which an exchange of ideas took place between the N.B.S. and manufacturers, with a view to developing better techniques for the manufacture and application of gauge blocks. The papers fall into three main categories: namely, the interferometric measurement of gauge blocks; size and metallurgical stability; and the standardization of gauge blocks. Methods described are representative of British, Canadian, German and American practice.

DIRECTORY OF SHIPOWNERS, SHIPBUILDERS, AND MARINE ENGINEERS, 1958. Published, for *Shipbuilding and Shipping Record*, by Tothill Press, Ltd., 33 Tothill Street, Westminster, London, S.W.1. [Price 40s. 0d. net.]

This useful directory, now in its 56th year of publication, is divided into 12 sections. It incorporates lists of shipowners, shipbuilders, marine engine builders, and dry-dock owners; trade and technical organizations; consulting naval architects, marine engineers, and ship surveyors; experiment tanks; classification societies; and British Government offices and officials. There are also ship, geographical, telegraphic address, general, and personal indexes.

INVENTORS AND INVENTIONS. By C. D. Tuska. McGraw-Hill Publishing Co., Ltd., 95 Farringdon Street, London, E.C.4. 174 pp. [Price 28s. 0d. net.]

To many, the subject of invention is fascinating, especially the history of important inventions. For thorough treatment, the legal and psychological, as well as the technical and social aspects must be considered. The author of this book has acquitted himself well in all these respects. Starting with the inventions of primitive man, he goes on to examine the effects of environment, education, age, and sex, and finally considers the ways in which an invention can emerge—by experiment, accident, or painstaking approach.

Perhaps the most important chapters are those devoted to patentable inventions and the marketing of inventions.

INSTRUMENT TECHNOLOGY, VOL. III—TELEMETERING AND CONTROL. By E. B. Jones, B.Sc., A.Inst.P. Butterworths Scientific Publications, Ltd., 88 Kingsway, London, W.C.2. 198 pp. [Price 40s. 0d. net.]

Among the greatest advances made in instrumentation during recent years has been the development of instruments for controlling manufacturing or industrial processes completely. Detailed information on many of the principles involved and the physical systems adopted for such purposes is included in this book. Telemetering systems described include those which involve pneumatic and electrical devices, together with the balanced-bridge arrangement. Electrical positioning systems are particularly well covered.

The subject of automatic control is conveniently covered in two parts, the first setting forth the theory, and the second describing some types of automatic controllers. Matters discussed include inherent regulation, performance of control systems, types of control action, theoretical response of 3-term controllers, and different control systems, including that based on the closed loop.

Three volumes, of which the book under consideration is the last, have been written to meet the needs of students preparing for the City and Guilds examinations in instrument maintenance, but they will obviously be of assistance to others.

ADVANCED FLUID DYNAMICS AND FLUID MACHINERY. By R. C. Binder, Ph.D. Longmans, Green & Co., Ltd., 6 and 7 Clifford Street, London, W.1. 426 pp. [Price 60s. 0d. net.]

Fluid dynamics, as a result of many modern applications, now covers a very wide field, embracing, on the one hand, fairly simple conventional hydraulics for which the medium is exclusively water, and, on the other, systems involving compressible fluids and the viscous incompressible liquids. The author of this book has not covered such a range, but has confined his attention mainly to compressive fluids, so applied that the action is chiefly dynamic. For this reason, all consideration of positive displacement pumps and motors has been omitted, and the emphasis is on centrifugal pumps, axial flow fans and pumps, fluid couplings and torque converters, and turbines.

Within its scope, however, the book deals in a thorough and informative manner with the theory and performance of such units, and basic fluid flow. More advanced aspects covered include unsteady flow in one direction, steady 2-dimensional flow, for both incompressible and compressible fluids, and some analytical relations for viscous flow. Thermo-dynamic and energy considerations are handled in a masterly fashion.

WELDING HANDBOOK (FOURTH EDITION), PART I—BASIC PRINCIPLES AND DATA. American Welding Society. London: Cleaver-Hume Press, Ltd., 31 Wrights Lane, W.8. 560 pp. [Price 72s. 0d. net.]

The handbook of the American Welding Society has been used extensively as a work of reference for a number of years. It is now being completely revised, and the volume here considered affords an indication of the manner in which the revision is being undertaken. There are eleven chapters, of which the first are concerned with welding terms, engineering data, fundamentals of welding metallurgy, and properties of welded joints. Next, chapters are included on the thermal and mechanical treatment of welded parts, the design of welded joints, factors involved in estimating costs, and the inspection of welds. The three last chapters are concerned with standard methods for the mechanical testing of welds, statistical control of weld quality, and safe practices in welding and cutting. Information is not confined to any one system of welding, but a comprehensive yet concise survey is presented of all systems, including the gas, arc, and resistance methods, together with modifications of these methods for special purposes. A considerable amount of valuable practical data is provided.

Industrial Notes

SWAN HUNTER & WIGHAM RICHARDSON, LTD., Walker-on-Tyne, are to build, under licence, the Pescara free-piston gas engine.

W. E. SYKES, LTD., Staines, Middlesex, have opened new offices at Grove House, Sutton New Road, Erdington, Birmingham, 24 (telephone number, Erdington 7491). The company's Midlands representative, Mr. P. Franks, is now operating from these offices.

BROADWAY EQUIPMENT, LTD., Parway House, 194-196 Finchley Road, London, N.W.3, have been appointed sole agents in the United Kingdom for the sale of tube notching machines and universal punching presses made by Georg Lindemann, Western Germany.

UNIVERSAL DIAMOND CO., LTD., 15 Rodmarton Mews, Baker Street, London, W.1, have appointed Longley Tools, Pelican Chambers, 9 Brooks Yard, Huddersfield, as representatives in Yorkshire for the sale of their diamond tools and industrial diamonds.

MACHINE TOOL DELIVERIES during November were valued at £7,685,000 (including £1,650,000 for export). Orders booked during the month totalled £6,107,000 (£1,385,000). At the end of November the value of orders in hand was £80,556,000 (£20,006,000).

GEORGE COHEN SONS & CO., LTD., Sunbeam Road, London, N.W.10, announce that they have purchased the whole of the machine tool plant which has become available following the decision of Associated Commercial Vehicles, Ltd., to close down the works of Crossley Motors, Ltd., at Stockport.

BRITISH CONSOLIDATED FOUNDRY PLANT MANUFACTURERS, Hanover Court, Hanover Street, London, W.1, is a consortium for co-ordinating the export of the following member companies' foundry machinery and foundry plant products:—The Acme Group; The Coleman-Wallwork Co., Ltd.; Metalectric Furnaces, Ltd.; Paterson Hughes Engineering Co., Ltd.; and Tilghman's, Ltd.

ELECTRO-CHEMICAL ENGINEERING CO., LTD.—A 5,000-sq. ft. extension to the company's offices at Sheerwater, near Woking is scheduled for completion in May. The additional space is required for an expansion of the firm's engineering department, and to accommodate a new accounts and costing department, also a room where technical films may be shown.

THE SOUTH DURHAM STEEL AND IRON CO., LTD., have placed orders valued at £4,000,000 with Davy and United Engineering Company Limited, Sheffield, for the supply of rolling mill equipment as part of their extension programme. The plant will include two rolling mills, each driven by twin 4,500-h.p. motors and a 2,750-ton hydraulic hot slab shear.

PRATT & WHITNEY CO., INC., West Hartford, 1, Connecticut, U.S.A. In a recent issue of the company's house journal, *The News*, reference is made to an interesting jig boring operation recently undertaken on a Pratt & Whitney machine arranged for tape control. The operation involved drilling and reaming 1,420 holes in a plate, with a spacing error between any two holes not exceeding 0·001 in.

EMPLOYMENT IN THE MANUFACTURING INDUSTRIES.—Although there was a reduction of 16,000 in the number of people employed in manufacturing industry during November (from 9,237,000 to 9,221,000), the numbers for "vehicles" and "engineering, metal goods, and precision instruments" increased by 3,000 and 2,000 respectively. For "metal manufacture" there was a fall of 1,000.

RECORD AIRCRAFT EXPORTS IN 1957.—The Society of British Aircraft Constructors recently announced that the value of exports of British aircraft in December last reached the record monthly total of £17,516,043. For the year 1957 the value of exports, at £116,471,110, was also a record, and represented an increase of 11·5 per cent as compared with the previous record annual figure of £104,500,000 in 1956.

ELGAR MACHINE TOOL CO., LTD., inform us that their Midlands office has been transferred from Leamington Spa to 1075 Kingsbury Road, Castle Bromwich, Birmingham, 24 (telephone number, Castle Bromwich 2178). There is a large showroom at the new address, and during the period from February 17 to 22 a wide range of machine tools will be demonstrated under power. All engineers interested are invited to attend these demonstrations.

SPE CO., LTD., is the new title of the firm of aeronautical electrical, mechanical, and hydraulic engineers, formerly known as the Self-priming Pump & Engineering Co., Ltd. The address, as before, is Trading Estate, Slough, Bucks., and the London office is now at 20-26 Lamb's Conduit Street, W.C.1. The company is associated with The Pulsometer Engineering Co., Ltd., Nine Elms Iron Works, Reading.

K & L STEELFOUNDERS & ENGINEERS, LTD., Letchworth, have despatched a Jones KL 10-10 "Fast Travel" mobile crane which is to be displayed at the forthcoming Leipzig International Fair. To solve the problem of transport, the crane will travel by road, under its own power, from Rotterdam to Leipzig. Jones cranes are marketed in the United Kingdom by George Cohen Sons & Co., Ltd., Wood Lane, London, W.12.

AN ELECTRONICS IN INDUSTRY EXHIBITION will be held at the Industrial Showroom of the Midlands Electricity Board, 247 Chester Street, Aston, Birmingham, 6, in conjunction with the Metropolitan Vickers Co., Ltd., from February 24 to March 7. Exhibits will include analogue computer equipment, Magister transistor relay and static switching equipment, a high-frequency plastics welder, an electronically-controlled variable speed drive,

counting units and a speed meter. This exhibition will be open (admission free) from 10.0 a.m. to 12.0 noon and from 2.0 p.m. to 4.30 p.m., Mondays to Fridays.

THE ELECTRONIC MACHINE CO., LTD., and THE ELLIS OPTICAL CO., both of Mayday Road, Thornton Heath, Surrey, have merged. The former company are makers of electronic equipment including counters, batch-counters, process timers, industrial control equipment and instruments. In addition they undertake sub-contract work. Products of The Ellis Optical Co. are largely complementary and it is stated that the combined production resources will enable output to be substantially increased.

STANDARD FOR DIAMOND WIRE DRAWING DIES. A revised British Standard (B.S.2946:1958) has been issued to cover both reinforced and non-reinforced diamond dies for wire drawing, to supersede B.S.1393 and B.S.1168. It includes clauses on quality of die stones, bore of die, mounting, casing, size, assembly of die, and marking. In one of the appendices there is a recommended summary of the information to be supplied with an enquiry or order. Copies of the specification (price 4s. net) can be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1.

DAVID BROWN MACHINE TOOL EXPORTS.—The Machine Tool Division of David Brown Industries, Ltd., Sherborne Street, Manchester, report that they despatched a record volume of gear-cutting plant—nearly 400 tons in all—during the six weeks ended January, 1958. A large proportion of these exports was sent to Italy, Sweden and Japan. The Italian consignment comprised two large turbine gear machines for Ansaldo S.A. of Genoa. The latest order for France, from a Nantes (Brittany) firm, is for two large machines for producing turbine gears and pinions up to 220 and 60 in. diameter, respectively.

AN AUCTION SALE OF MACHINE TOOLS, plant, canteen equipment, and office furniture from Wm. Beardmore & Co., M.O.S. Agency Factory, Linwood Road, Paisley, will be held at Linwood on February 27, and at Central Halls, 25 Bath Street, Glasgow, C.2, on February 28. The auctioneers will be Shirlaw Allan & Co. (Dept. N), Keith Street, Hamilton. Another sale, of machine tools and miscellaneous stores, from Technical Stores Depot, Old Dalby, Melton Mowbray, Leics., will be held at Melton Mowbray on March 5 and 6. The auctioneers will be Shouler & Son (Dept. N), 1 Norman Street, Melton Mowbray, Leics.

Coming Events

INCORPORATED PLANT ENGINEERS. *Kent Branch.* February 19, at 7 p.m., at the Kings Head Hotel, High Street, Rochester; paper on "Applications of Photography in Science and Engineering," by J. F. Padday.

INSTITUTION OF PRODUCTION ENGINEERS. *Wolverhampton Graduate Section.* February 19, at 7.30 p.m., at the Wolverhampton and Staffs. College of Technology, Wulfruna Street, Wolverhampton; lecture on "Ferrous Die Casting," by H. E. Redshaw. *Lincoln Section.* February 20, at 7.30 p.m., at the Ruston Club, Lincoln; lecture on "The Computer Control of Machine Tools," by M. Monk, B.Sc. *Peterborough Section.* February 18, at 7.30 p.m., in the Conference Room, Peterscourt, Peterborough; lecture on "Electric Welding," by J. W. Wright, B.Eng.(Hons.). *Preston Section.* February 19, at 7.30 p.m., at the Harris College of Further Education, Corporation Street, Preston; lecture and film on "Application of Tungsten Carbide Cutting Tools," by H. H. Ward and N. Shaw. *Stoke-on-Trent Section.* February 24, at 7.30 p.m., at the Grand Hotel, Hanley, Stoke-on-Trent; lecture on "Design for Production," by F. E. Butcher. *Northern Ireland Section.* February 20, at 7.30 p.m., at the Kensington Hotel, Belfast; lecture on "Machining Techniques for Non-Ferrous Materials," by S. Radcliffe, B.Sc.(Tech.). *London Section.* February 20, at 7 p.m., at the Royal Empire Society, Northumberland Avenue, Strand, W.C.2; lecture on "Research on Modern Metal-cutting Techniques," by J. Cherry. *Southampton Section.* February 20, at 7.15 p.m., at the Polygon Hotel, Southampton; lecture on "Manufacture of Electric Power Cables," by Dr. Arman.

INSTITUTION OF MECHANICAL ENGINEERS. *London Graduate Section.* February 20, at 6.30 p.m., at the Institution, 1 Birdcage Walk, Westminster, S.W.1; paper on "History of Mechanical Engineering up to 1840," by G. Porges. *Yorkshire Graduate Section.* February 20, at 6.30 p.m., at the Hotel Metropole, Leeds; paper on "Precision Finishing Machines and Operations," by E. D. Haigh.

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14/2/58

Personal

MR. J. W. GOWLAND has been appointed manager of the new factory of Canadian Pollard Bearings, Ltd., at Oakville, Ontario, Canada.

MR. SELBY G. WORTHINGTON has been appointed metallurgist for The Dart Spring Co., Ltd., West Bromwich, in succession to Mr. F. Cowlishaw, who has left the company.

MR. W. T. H. CARTER has been appointed chief buyer for the Instrument Division of George Kent, Ltd., Luton, Beds.

MR. J. O. FOX has been appointed sales representative for Frank Guylee & Son, Ltd., Millhouses, Sheffield, 8, for South Yorkshire, Derbyshire, Nottinghamshire, Lincolnshire, Cheshire and the Eastern Counties.

MR. DAVID H. BRAMLEY, M.I.Mech.E., head of the Department of Industrial Administration at the College of Technology, Birmingham, has joined the board of Geo. Salter & Co., Ltd., West Bromwich.

He will continue to hold his college post.

MR. A. W. SARGENT, who formerly was associated with Tarex (England), Ltd., and C.V.A. Jigs, Moulds & Tools, Ltd., has joined the technical staff of Geo. Kingsbury & Co., Ltd. (Machine Tools), 54 Victoria Street, London, S.W.1.

MR. P. K. HART has been appointed to the board of Qualters & Smith Bros., Ltd., Barnsley, Yorkshire, and MR. J. DUNKERLEY to the board of Henry Broadbent, Ltd., Sowerby Bridge, Yorkshire. These companies are manufacturing subsidiaries of Kerrys (Great Britain), Ltd.

MR. S. TEASDALE has been appointed technical representative for Martonair, Ltd., Parkshot, Richmond, Surrey, for South Manchester and an area enclosed by Chester, Crewe and Oldham. MR. R. G. BARNES will continue to represent the company in the Sheffield area.

MR. J. W. MACMAHON has been appointed general manager of the Industrial Lubricants Division of Wakefield-Dick Industrial Oils, Ltd., in succession to Mr. R. J. Turner who has retired. Mr. MacMahon has also been made a director of the company.

MR. J. I. PATON has been appointed sales manager and MR. W. THOMSON chief technical representative for Carron Company, Carron, Falkirk, Stirlingshire. MR. J. MACPHERSON is now works manager of the company's engineering department.

MR. A. J. BEANLAND, B.Sc.Tech., M.I.E.E., A.M.I.Prod.E., Fellow A.M.I.M.E., has been appointed a director of Lancashire Dynamo Group Sales, Ltd., with responsibility for organization of the sales of the Lancashire Dynamo Group, at home and overseas.

MR. N. G. WORSTER, A.M.I.E.E., A.M.I.Mech.E., A.I.Loco.E., F.B.H.I., has been appointed chief development engineer of Measuring Instruments (Pullin), Ltd., Electrin Works, Winchester Street, Acton, London, W.3. He was formerly with S. Smith & Sons (England), Ltd., where he was responsible for the design of many of the Group's products.

MR. J. RUSSELL KNOWLES recently retired after nearly 50 years' service with Gulf Oil (Great Britain), Ltd., 6-7 Grosvenor Place, London, S.W.1, and 25 years as managing director. MR. NORMAN EDMENSON has been appointed to succeed Mr. Knowles as managing director, and Mr. J. R. SMELLIE has been appointed vice-managing director.

MR. J. W. CHENEY, who has been Northern Area manager for Newman Industries, Ltd., Plant and Machinery Division, for the past eight years, has been appointed North of England and Scottish representative for Harry Kirk Engineering, Ltd., Brandon Road, Coventry. He will handle both the purchase and sale of machine tools from 22 Ringway Road, Manchester 22 (telephone number, Gatby 8276).

MR. V. HUFFAM, A.M.I.Mech.E., asks us to state that there is no foundation for reports which have been circulating to the effect that he intends to resign from the positions of chairman and managing director of V. Huffam, Ltd., and that he hopes to continue to hold these posts for some years. Mr. Huffam recently left for South Africa where he will be occupied with promoting the sales of spacing collars and slip gauges. He will also introduce to this market a new design of jig and a new height gauge.

MR. A. D. BAILEY, A.M.I.Mech.E., A.M.I.E.E., who has been manager of the Newcastle-on-Tyne sales office of Brook Motors, Ltd., Huddersfield, for the past 4½ years, has taken over the management of the company's Birmingham office. He succeeded MR. T. HERD, who has been in charge at Birmingham since 1946, and will shortly take up a new appointment with the company. MR. H. BOOTHROYD, hitherto sales engineer, has been appointed manager at Newcastle-on-Tyne, and MR. R. SUGDEN, sales engineer. Mr. Sugden previously had held a similar position at Norwich since 1955.

U.S. Machine Tool Exports

The following table gives the quantities and value of export of various classes of machine tools from U.S.A. during May, 1957:—

	Number	Value, $
Engine and tool room lathes	87	314,332
Light duty and bench lathes	195	96,047
Turret lathes	31	514,430
Other lathes	78	1,738,119
Vertical boring and turning mills	5	115,245
Boring machines	21	994,942
Tapping and threading machines	123	234,991
Milling machines	115	867,399
Gear-cutting machines	41	847,156
Gear grinding and finishing machines	26	437,671
Drilling machines	221	430,174
Planing, shaping and slotting machines	17	120,360
Surface grinding machines	55	367,004
Tool and cutter grinding machines	123	223,162
Other grinding machines	42	832,032
Honing and lapping machines	23	192,140
Broaching machines	19	687,423
Sheet and plate metal-working machines	397	2,955,803
Forging machines and hammers	48	720,673
Metal-forming machines	—	672,614
Other machines	1,066	1,222,813

Obituary

MR. K. D. MARSDEN, who has represented J. A. Crabtree & Co., Ltd., Walsall, in North Wales and West Lancashire for more than 30 years, died on February 2, at the age of 60. Born in Walsall, he received his early engineering training with the Renault company in France, and joined J. A. Crabtree & Co. in 1925.

MR. ROBERT K. FLEMING, honorary president of Igranic Electric Co., Ltd., Bedford, died on February 3 at the age of 66. He joined the company in 1924, and was appointed managing director in 1941, a position which he held until 1953. As a result of ill health, he was then compelled to give up active management, but became chairman of the board.

During his long association with the firm, Mr. Fleming became well known in the motor control gear field, and his knowledge and wide experience of the application of control gear in the steel industry were recognized by steel companies throughout the country.

Machine Tool Share Market

Stock markets were mainly firm during the past week. Prices advanced steadily in most sections, and there was some expansion in the volume of business.

Interest was centred mainly in the gilt-edged section, where British Funds and similar high-grade investment stocks displayed activity and strength.

Commercial and industrial share markets were moderately active, and, for the most part, there was a tendency for prices to move to slightly higher levels. A fair amount of selective buying was maintained, and although leading sections closed on a dull note, numerous small gains were shown on balance.

Among machine-tool issues, Arnott & Harrison advanced 3d. to 14s. 3d.; Geo. Cohen, 6d. to 11s.; Alfred Herbert, 2s. 6d. to 60s.; Modern Engineering, 6d. to 11s.; F. Pratt, 1s. 3d. to 19s. 9d.; and Scottish Machine Tool, 6d. to 5s. 3d. On the other hand, Abwood Machine Tool lost 3d. at 9d.; Broom & Wade, 3d. at 10s. 3d.; John Harper, 3d. at 14s. 1½d.; Samuel Osborn, 3d. at 17s.; Edgar Allen, 9d. at 29s.; Churchill Machine Tool, 1½d. at 17s. 4½d.; Coventry Gauge & Tool, 1s. 7½d. at 14s. 6d.; and Stedall & Co., 6d. at 4s. 9d.

NOBLE & LUND, LTD.—Final dividend of 14 per cent, making, with the interim already paid, a total distribution of 20 per cent for 1957, which was 1½ per cent more than for the preceding year.

COMPANY		Demon.	Middle Price
Abwood Machine Tools, Ltd.	Ord.	1/-	9d.
Armstrong, Stevens & Son, Ltd.	Ord.	5/-	7/9
Allen (Edgar) & Co., Ltd.	Ord.	£1	29/-
" " "	5% Prf.	£1	15/-*
Arnott & Harrison, Ltd.	Ord.	4/-	14/3
Asquith Machine Tool Corp., Ltd.	Ord.	5/-	21/3
" " "	6% Cum. Prf.	£1	17/9
Birmingham Small Arms Co., Ltd.	Ord.	£1	26/-
" " "	5% Cum. "A" Prf.	£1	15/6
" " "	6% Cum. "B" Prf.	£1	17/6
" " "	4% 1st Mort. Deb.	Stk.	84½
British Oxygen Co., Ltd.	Ord.	£1	30/-
" " "	6½% Cum. Prf.	£1	21/6
Brooke Tool Manufacturing Co., Ltd	Ord.	5/-	5/6
Broom & Wade, Ltd.	Ord.	5/-	10/3
" "	6% Cum. Prf.	£1	17/9
Brown (David) Corporation, Ltd.	5½% Cum. Prf.	£1	14/4½
Buck & Hickman, Ltd.	6% Cum. Prf.	£1	17/6
Butler Machine Tool Co., Ltd.	Ord.	5/-	6/6 ex rights
" " "	5% Cum. Prf.	£1	13/9
C.V.A. Jigs, Moulds & Tools, Ltd.	5½% Red. Cum. Prf.	£1	13/9
Churchill (Charles) & Co., Ltd.	Ord.	2/-	4/9
" " "	6% Cum. Prf.	£1	26/3†
Churchill Machine Tool Co., Ltd.	Ord.	5/-	17/4½
" " "	6% Cum. Prf.	£1	18/9
Clarkson (Engrs.), Ltd.	Ord.	5/-	10/6
Cohen (George), Son & Co., Ltd.	Ord.	5/-	11/-
" " "	4½% Cum. Prf.	£1	14/3
Coventry Gauge & Tool Co., Ltd.	Ord.	10/-	14/6
" " "	5% Cum. Red. Prf.	£1	16/3
Coventry Machine Tool Works, Ltd.	Ord.	4/-	8/6
Craven Bros. (Manchester), Ltd.	Ord.	5/-	5/9
Elliott (B.) & Co., Ltd.	Ord.	1/-	3/-xd
" "	4½% Red. Cum. Prf.	£1	13/9
Export Tool & Case Hardening Co., Ltd.	Ord.	2/-	1/9
Firth Brown Tools, Ltd.	4% Cum. Prf.	£1	12/-
Greenwood & Batley, Ltd.	Ord.	£1	46/10½
Harper (John) & Co., Ltd.	Ord.	5/-	14/1½
"	4½% Red. Cum. Prf.	£1	12/9
Herbert (Alfred), Ltd.	Ord.	£1	60/-
Holroyd (John) & Co., Ltd.	"A" Ord.	5/-	11/-
" " "	"B" Ord.	5/-	10/-
Jones (A. A.) & Shipman, Ltd.	Ord.	5/-	21/3
" " "	7% Cum. Prf.	5/-	5/-
Kayser, Ellison & Co., Ltd.	Ord.	£1	54/-
" " "	6% Cum. Prf.	£1	18/3
Kendall & Gent, Ltd.	Ord.	5/-	7/9
Kerry's (Gt. Britain), Ltd.	Ord.	5/-	5/9
Kitchen & Wade, Ltd.	Ord.	4/-	10/9
Martin Bros. (Machinery), Ltd.	Ord.	2/-	2/4½
Massey, B. & S., Ltd.	Ord.	5/-	7/3
Modern Engineering Machine Tools, Ltd.	Ord.	5/-	11/-
Newall Engineering Co., Ltd.	Ord.	2/-	5/-
Newman Industries, Ltd.	Ord.	2/-	2/9
" "	6% Prf. Ord.	5/-	5/6
Noble & Lund, Ltd.	Ord.	2/-	4/9
Osborn (Samuel) & Co., Ltd.	Ord.	5/-	17/- ex rights
	5½% Cum. Prf.	£1	25/-
Pratt (F.) & Co., Ltd.	Ord.	5/-	19/9
Scottish Machine Tool Corporation, Ltd.	Ord.	4/-	5/3
Shardlow (Ambrose & Co., Ltd.	Ord.	£1	35/-
Shaw (John) & Sons, Wolverhampton, Ltd.	Ord.	5/-	12/4½
Sheffield Twist Drill & Steel Co., Ltd	Ord.	4/-	35/-
" " "	5% Cum. Prf.	£1	15/-
Stedall & Co., Ltd.	Ord.	5/-	4/9
Tap & Die Corporation, Ltd.	Ord.	5/-	7/9xd
" " "	4½% Deb. 1961-1977	Stk.	82/-
Wadkin, Ltd.	Ord.	10/-	19/6
Ward (Thos. W.), Ltd.	Ord.	£1	73/6
" "	5% Cum. 1st Prf.	£1	15/6
	5% Cum. 2nd Prf.	£1	24/6
Willson Lathes, Ltd.	Ord.	1/-	2/4½

The Middle Prices given in the list are in several cases nominal prices only and not actual dealing prices. Every effort is made to ensure accuracy, but no liability can be accepted for any error. * Sheffield price. † Birmingham price.

PRICES OF MATERIALS

All prices per ton except where otherwise stated.

Pig-Iron

Foundry and Forge No. 3, Class 2

Middlesbrough zone	£21 6 0
Birmingham	£20 18 3

Phos. 0·1 to 0·75%

Birmingham	£23 17 0

Scottish Foundry

Grangemouth	£25 3 6

Hæmatite English No. 1

N.E. and N.W. Coast	£25 6 6
Scotland	£25 13 0
Sheffield	£26 15 0
Birmingham	£27 4 0

Welsh £25 6 6

Steel Products

Medium plates	£46 1 6
Mild steel plates, ordinary*	£42 12 0
Boiler plates*	£45 2 0
†Flat bars 5 in. wide and under } †Round bars under 3 in. }	£40 8 0
Billets, rolling quality, soft U.T.	£33 1 6

Phosphor Bronze

Ingots (2B8) (A.I.D.) d/d	£235 0 0

Copper

Cash (mean)	£160 12 6
Cold rolled and hot rolled Sheets 4 ft. by 2 ft. by 10 SWG	£229 5 0—£229 15 0
Rods $\frac{7}{16}$ in. to $\frac{3}{4}$ in. diam.	£248 15 0
Tubes, 1¼ in. bore by 10 SWG, ton lots, per lb.	2s. 5½d.
Wire rod, black, hot-rolled ($\frac{1}{4}$–$\frac{7}{16}$ in.) English	£178 2 6

Zinc

Refined, minimum 98 per cent. purity, current month (mean)	£64 2 6

Brass

Tubes, solid draw, per lb.	1s. 4½d.
Strip 63/37, 6 in. by 10 SWG coils, ton lots	£202 15 0—£205 5 0
Rods, $\frac{1}{4}$–3 in. diam. (59 per cent copper)	1s. 7⅞d.

Yellow Metal

Condenser plates, per ton	£141 0 0
Rods, per lb.	1s. 8⅛d.

Aluminium

Ingots min. 99·5 per cent Canadian d/d	£197 0 0

Lead

Refined, minimum 99·97 per cent purity, current month (mean)	£73 11 3

Tinplates

‡U.K. Home trade:

Handmill f.o.t. makers' works	£3 12 2½
Cold reduced, f.o.t. makers' works	£3 7 10½

U.K. Export:

Hot rolled basis, f.o.t. works' port	74s. 0d.—75s. 0d.
Cold reduced basis, f.o.t. works' port	76s. 0d.—76s. 6d.

Gunmetal

Ingots, 85.5.5.5. ex works	£157 0 0

*N.E. Coast, N. Joint Area, Central Scottish Zone.

†U.T. soft basic.

‡Official maximum price, after allowing for adjustments for increase in price of tin.

MAKERS' PRICES

Hexagon Steel Bars[1]

Sizes in inches from 0·7049 up to 2·21 and 2·41 a/f, ex works basis	£43 4 6
Free cutting black	£47 10 0

Reeled Steel Bars[1]

Single-reeled 1½ in. upwards, f.o.t. works (+ usual extra for sizes)	£43 17 6
Free cutting	£48 2 6

High-Speed Steel

Black random length bar. All prices basic, per lb., subject to extras.

Molybdenum "66"	5s. 10½d.
Molybdenum "46"	5s. 8½d.
14 per cent tungsten	5s. 9d.
16 per cent tungsten	6s. 1½d.
18 per cent tungsten	6s. 4d.
22 per cent tungsten	7s. 5d.
5 per cent cobalt 4·75/5·25 per cent molybdenum + 6·0/6·75 per cent tungsten + 1·75/2·05 per cent vanadium (5-6-2)	9s. 6d. 6s. 0½d.

Precision-ground, High-speed Free-turning Brass Rod[2]

⅜-in. dia. ± 0·00025-in. 2-ton lots, per lb.	2s. 2½d.

Grey Iron Rod

Die Cast[3] in random lengths 18 in. to 24 in. rough machined ⅛-in. above listed size. Extra for definite lengths, for hardenable alloy iron, and for orders of less than £50. Discounts for orders over £150.

	Per cwt. net. Mark I	Mark III
⅜ or ½ in.	255s. 6d.	318s. 10d.
1 or 1⅛ in.	204s. 4d.	251s. 10d.
1¼ to 1½ in.	143s. 0d.	171s. 2d.
1⅝ to 2 in.	106s. 2d.	125s. 11d.
2⅛ to 3½ in.	91s. 6d.	106s. 4d.
3⅝ to 12 in.	86s. 6d.	99s. 2d.

Continuous Cast

10-ft. lengths, centreless machined 1 to 3-in. dia. + 0·010 to 0·020 in., prices as quoted for die cast bar[3]

6-ft. lengths centreless ground + 0·010 in. Extra for hardenable alloy iron[4] Per cwt. net.	⅜ or ½ in.	245s. 4d.
	1 or 1⅛ in.	196s. 4d.
	1¼ to 1½ in.	137s. 10d.
	1⅝ to 2 in.	106s. 2d.
	2⅛ to 3 in.	91s. 6d.

Stellite[5]

Welding Rods (plain

¼ in. dia. per lb.	30s. 0d.

Toolbits

¼ in. sq. × 4 in., each	22s. 3d.

Precision-ground Mild Steel[2]

1-in. dia. ± 0·00025-in. 4-ton lots, per cwt.	121s. 6d.

[1] Colvilles, Ltd., Glasgow, and 17 Grosvenor Street, London, W.1. [2] Pratt, Levick & Co., Ltd., Chester. [3] Sheepbridge Alloy Castings, Ltd., Sutton-in-Ashfield. [4] "Flocast." Harold Andrews Sheepbridge, Ltd., Halesowen. [5] Deloro Stellite, Ltd., Highlands Road, Shirley, Solihull.

BASIC PRICES FROM LONDON STOCK[6]

Free Cutting Steel

Bright cold drawn: (Usaspead) over 1½ to 2 in.	£59 17 6
Lead bearing (Usaled)	£63 17 6
Precision ground, 1½ in.	£81 12 6

Bright Drawn

M.S. bars (M.M.C.) over 1½ in. to 2 in.	£55 8 6
Square edge flats (Usaflat)	£72 5 0
M.S. angles (Usaspead)	£99 10 0
Casehardening (EN) (Usacase) over 1½ in. to 2 in.	£63 14 6
M.S. bars (EN3B) (Usamild) over 1½ to 2 in.	£57 8 6
Carbon manganese semi-freecutting case hardening (EN202) (Usaspead 202) over 1½ to 2 in.	£71 14 0
35/45 ton tensile (EN6) (Usan) over 1 to 1½ in.	£65 2 6
0·4 Carbon Normalised (Usaspead "40") over 1½ in. to 2 in.	£67 4 6
Carbon manganese steel to Specification EN.16.T (Usaspead 5565), per ton	£127 10 3

Ground Flat Stock

18-, 24-, and 36-in. lengths (Usaspead). List prices less 5 per cent

Oil Hardening Cast Steel

Non-shrink (Usaspead N.S.O.H.) ¾ in. to 2¾ in., per lb.	1s. 11d.
Non-distorting heavy duty (Usaspead H.C.H.C.) ¾-in. to 2¾-in., per lb.	4s. 2d.

Silver Steel

(0·194-in. to 1¼-in.)

Genuine Stubs quality, per lb.	4s. 6d. less 27½%
M.M.C. quality, per lb.	2s. 5d. + 6½%
Boxes of 16 assorted sizes $\frac{1}{16}$-in. to ¾-in. dia.	7s. 6d.

Stainless Steel

K.E. 40.AM (Freecutting), per lb. 3s. 3½d.

Glacier Machined Bronze Bars

Phosphor bronze (2B8) } Lead bronze }	Prices on application

High-speed Steel

18 per cent. tungsten. Prices on application. Toolholder bits:

Usaspead "Super" } " "Supreme" } " Cobalt 10 }	List price

Shimstock

Steel assorted, per tin	3s. 6d.
Brass " "	7s. 3d.

[6] Macready's Metal Co., Ltd., Pentonville Road, N.1. Subject to confirmation by London Office. Delivered free by van in London area.